ON06042

Innovative In-Service in Elementary Science

FINAL REPORT to MINISTRY of EDUCATION for 1988-1989

Joint Project sponsored by
The Ontario Ministry of Education
together with
The Frontenac County Board of Education
and
The Frontenac, Lennox & Addington R.C.S.S.B
Kingston, Ontario

93-02021/

Innovative Inservice in Elementary Science:

Final Report to the Ontario Ministry of Education on a Two Year Program of Inservice Education in Science for Elementary School Teachers

---

by GEORGE (SKIP) HILLS, External Evaluator
February, 1990

This project was jointly funded by the Ontario Ministry of Education with matching funds provided by The Frontenac County Board of Education and The Frontenac, Lennox & and Addington R. C. S. S. B. in Kingston, Ontario.

Table of Contents

Introduction 3

I. Science, Society and Scientific Literacy: Background to the Project 5

II. "The Science Club": A Program of In-service Education in Science for Elementary Teachers 10

A. A Brief History of the "Science Club" 10

B. Aims of the Project 11

C. Context of the Project: Activities and Assumptions 13

III. The First Two Years of the Science Club: An Assessment 17

A. Assessment Strategies 18

B. Vignettes from the 1987-88 Science Club Interviews 21

C. Assessment in the Second Year: Teachers Write About the Science Club 58

IV. Conclusions 69

Footnotes 78

References 79

Appendices 81

One of the nicest stories of this kind that I know comes from a young physicist friend who was very learned. He had just got his Ph.D. and of course he understood everything. (The Ph.D. has been called "the certificate of omniscience") My wife was asking him to explain something to her about two coupled pendulums. He said, "Well, now, you can see that there's a conservation of . . . Well, there's really a conservation of angle here." She looked at him. "Well you see, the transfer of energy from one pendulum to the other there is . . . " and so on and so on. And she said, No, I don't mean that. I want you to notice this and tell me what's happening." Finally he looked at the pendulums and saw what she was asking. He looked at ***it****, and he looked at* ***her****, and he grinned and said, Well I know the right words but I don't understand either." This confession, wrung from a potential teacher, I have always valued very much. It proves we are all in it together. David Hawkins,* ***I, thou and it.*** *(p. 62).*

INTRODUCTION

If we assume that an essential ingredient in the preparation of science teachers involves having them come to understand not only important aspects of the subject matter of science but also the nature of science and of scientific inquiry itself, the question arises, "By what means are we most likely to be successful in fostering this type of understanding?". In the past few years our work has focused on the in-service education of elementary school teachers. Enabling elementary teachers to arrive at this kind of understanding is often thought to present a special challenge since, unlike the majority of their counterparts who teach science in the secondary school, they typically have had little preparation in science. As The Science Council of Canada's (1984) report *Science for every student: Educating Canadians for tomorrow's world* points out, "..., three-quarters of those teaching science [in the elementary school] have had no formal education in science since they were in high school" (p. 55). And there is evidence to suggest that Canadian schools are by no means peculiar in this regard– cf., Stake and Easley (1978). For this reason, science is thought to be either a neglected or an inadequately developed component in the curriculum of the elementary school. In the words of the Science Council's Report, "Most children from kindergarten to the end of elementary school only receive a token education in science..." (p. 33). How then might we attempt to enhance the quality of science presented in the elementary school?

This report outlines our efforts to address this larger issue by describing some of the things we have begun to learn from our involvement with forty elementary teachers– most of whom had had very little formal science in their educational backgrounds, in an ongoing program of in-service education aimed at taking up certain elements of this wider challenge. The overall goal of the project, now in its third year, is to enhance the quality of science teaching and learning in elementary classrooms by raising teachers' 'comfort level' both with science and with the teaching of science. The problem of 'comfort level', as we more and more have begun to realize through our work, is due not simply to the fact that elementary teachers have had little prior experience with formal science instruction, but also, and more fundamentally, it stems from the fact that those encounters they have had are, for various reasons, now seen as having been frustrating, pointless, unproductive and even "painful". Instead of opening doors to new ways of understanding the world, their experiences with school science have in many instances left them with the conviction either that science is not worth doing or that it is beyond their reach.

From the beginning we were persuaded, based on the extensive in-school experience of the two instructors/coordinators, that a promising way of addressing the problem of 'comfort level' would be to invite the participants to engage in inquiry; inquiry not only into the sorts of hands-on activities and materials that might be used in classroom (i.e., the 'subject matter') but also into the way they went about learning and teaching science. The program of activities organized for the teachers is based on this assumption. More recently, however, we have begun to appreciate the critical importance, for the success of an undertaking of this nature, of another factor: namely, the gradual creation of an ongoing support group made up of "fellow travellers" who have gradually come to understand that, as Hawkins puts it, "we are all in it together". In other words, one of the major developments that has helped to encourage these teachers in their efforts to learn science and to try out new science activities in their classrooms is the emergence of what can best be described as 'a sense of community'. This has been especially noticeable in the past eighteen months during which time the program of in-service education has been transformed into what participants now refer to as "The Science Club".

This report is an attempt to take stock of the efforts of this project to date. Its primary aim is to explore the impact of the the program of activities in which the "Science Club" has been engaged for the past two years on the comfort level of the participating teachers. Are they more comfortable with science and science teaching than when they first became involved in the project two years ago? If so, in what particular ways have they benefitted from the experience? And what can be learned form the first two years that can help to shape the Club's future directions? Part III of the report will address these and a number of related questions drawing on the evaluations that were done at the end of each of the first two years. Part I traces the concern with elementary teachers lack of preparation in science to the growing concern with the widespread lack of scientific understanding thought to be prevalent in many western societies. In so doing, we outline some of our assumptions regarding the nature and origins of 'the problem of scientific literacy'– as it has often been referred to, which have helped to shape the in-service work we are doing with teachers. Part II sketches some of the principal features of the project by describing its aims, a number of its underlying assumptions, and the program of in-service activities in which we have been engaged during the first two years. And in Part IV we outline the main conclusions we concerning the role of the Science Club played as a vechicle of in-service teacher education in elementary science.

What, then, lies behind this concern with the quality of science teaching, particularly in the elementary school? In order address this question it is useful to outline something of the background to these contemporary concerns. It will help to shed light on our reasons for initiating the project and the approach we have taken in this program of in-service science education. Its roots lie in a concern with what has come to be known, in present day parlance, as "scientific literacy".

I. SCIENCE, SOCIETY AND SCIENTIFIC LITERACY: BACKGROUND TO THE PROJECT

The past thirty years have borne witness to serious and sustained efforts on the part of the community of science educators to make science available to a greater proportion of the general public than ever before. Nevertheless, recent reports such as those issuing from The National Science Foundation (Stake & Easely, 1978), The Science Council of Canada (1984) and The American Association for the Advancement of Science (1989), make it clear that a great deal remains to be done if we are to achieve even modest success in fostering wider public understanding of science.

In spite of differences in emphasis and in the populations studied, these reports suggest that a majority of those graduating from high schools, colleges and universities have an inadequate understanding of science and its role in today's society. Findings such as these are a cause for particular concern given that science and technology are coming to play increasingly influential roles in contemporary social life.

The consequences of the continued existence of a gulf between science, technology, and their varied cultural by-products, on the one hand, and the public's understanding of the scientific enterprise on the other, are matters of long-standing concern. John Dewey (1938) warned that until scientific method, "so sinks into the subsoil of the mind as to become an integral part of the corporate belief and attitude [it] will remain the possession of specialized experts and will exercise influence only by way of external and more or less disintegrating impact upon beliefs and by equally external practical application" (p. 338). For example, although we have accepted television and the airplane, we remain almost completely in the dark about their elementary scientific basis. In an apparently similar vein C. P. Snow (1959) expressed grave concern about one facet of this larger issue when he drew attention to

the "gulf of mutual incomprehension" he saw developing between literary intellectuals and physical scientists. Yet, whereas Snow deplored the indifference among the well-educated to the Second Law of Thermodynamics, what troubles science educators of today is something much more widespread and fundamental. It is the fact that most citizens do not understand the elementary scientific concepts, such as heat and energy, on which this and other more sophisticated laws and theories are based. In the light of the changes society is currently undergoing, the consequences of this kind of ignorance or misunderstanding must be seen as far reaching and profound. Given the escalating influence of science and technology on the social, moral and political orders, we run the risk, as Hawkins (1978) puts it, that, "most of us will remain or increasingly become what Arnold Toynbee called a 'cultural proletariat' in but not of the society we unwittingly constitute" (p. 8).

In the discussions surrounding these reports and their recommendations, a great deal of attention has been paid to the notion of scientific literacy. It is often suggested that, if we are to succeed in fostering a better understanding of science among the general public and in equipping citizens capable of intelligent participation in the society of the 21st Century, what is required is wider scientific literacy.

The trouble with such proposals is that the notion of scientific literacy on which so much seems to hinge is notoriously difficult to pin down. On some occasions, to speak of a person as being scientifically literate is to suggest that the person so described is functionally literate, which is to say that they are informed and can read and write about scientific matters with a modicum of understanding (Miller, 1983, p. 5). This is the narrower sense of the term. But it also has a much broader sense for, on other occasions, to describe someone as scientifically literate is tantamount to saying that they have been liberally educated. Perhaps the most notable recent example of the tendency to equate scientific literacy with being liberally educated is to be found in the AAAS's *Project 2061* (1989). The authors of this report take the position that:

> Scientific literacy–...– has many facets. These include being familiar with the natural world and respecting its unity; being aware of some of the important ways in which mathematics, technology and the sciences depend upon one another; understanding some of the key concepts and principles of science; having a capacity for scientific ways of thinking; knowing that science, mathematics and technology are human enterprises, and knowing what this implies about their strengths and limitations; and being able to use scientific knowledge and ways of thinking for personal and social purposes. (p. 20)

Elsewhere the report speaks of the benefits of an education in science as:

- providing humanity with the knowledge it needs to "develop effective solutions to it's global and local problems." (p. 12)
- fostering an "intelligent respect for nature." (p. 12)
- developing "Scientific habits of mind [that] can help people in every walk of life deal sensibly with problems that often involve evidence, quantitative considerations, logical arguments, and uncertainty;... [and] the ability to think critically and independently,...." (p. 13)

Similar views have been advanced by NSTA (1982), the NSF supported Project Synthesis (Yager, 1984) and The Science Council of Canada (1984). Indeed, the latter has taken the position that the overarching task of education in the sciences should be one of promoting scientific literary for all. From this it is evident that, using scientific literacy as its primary vehicle, the science education community is moving to significantly broaden the traditional, and much more circumscribed, role science has played in the context of a liberal education.

If we find these invitations for renewal compelling and go on to endorse this fundamental recasting of the goals of science education, then two critical points must be kept in mind if we are to be in a position to entertain a reasonable expectation of achieving these ends.

1. In spite of the novel emphasis on the social dimensions of science, the fact remains that basic to achieving these goals is the requirement that students develop some degree of mastery of the various forms of thought and awareness characteristic of scientific inquiry. That is, they must come to understand science "from the inside" rather than in some external or applied sense. This in turn requires that, together with certain basic principles and processes of inquiry, they acquire a meaningful grasp of those concepts which play a fundamental, organizing role within certain scientific disciplines.

2. From the outset we must face up squarely to the fact, underlined in these reports, that in spite of a quarter century of serious and sustained efforts to initiate pupils into the conceptual schemes of the sciences– supported by extensive curriculum development and a wide range of initiatives in teacher education, we seem to have fallen well short of the mark. In short, we embark in these new directions still confronted with those challenges which earlier initiatives in science education, likewise committed to fostering wider scientific literacy, have attempted but failed to meet.

These considerations lead us to some of the assumptions which underpin the present project. Indeed, four very broad questions underlie the work we describe in Parts II and III.

> First, how are we to account for the failure of previous efforts to initiate a greater proportion of pupils into science?
>
> Second, what might be done to better assist youngsters to acquire a more meaningful grasp of certain elementary scientific ideas– an understanding that supplies the conceptual bedrock on which an intelligent appreciation not only of technology but also of the social dimensions of science must be constructed?
>
> Third, what role might we reasonably expect elementary teachers to play in this larger undertaking?
>
> And, finally, what kind of educational experiences in science and in learning to teach science will enable these teachers to play such a role?

Clearly these questions are very complex. Yet it seems plain that we must begin by addressing the first of these if we are to have a reasonable prospect of meeting the challenges presented by the others. Why, then, despite a quarter century or more of activity aimed at helping students understand the conceptual schemes of the sciences does this well documented and widespread lack of understanding persist?

Various explanations have been proposed to account for this state of affairs (e.g., NSF, 1978; SCC, 1984; Yankwich, Eberhardt, Lavallee, & Schwartz, 1984; AAAS, 1989). Some have suggested that the curriculum and its supporting materials such as textbooks are the culprits. Others maintain that the learning opportunities provided are to blame, claiming, for example, that there is too little opportunity for "hands on" laboratory experience, or that the available equipment is outdated, or that classrooms are overcrowded, and so on. And still others have taken the position that an important part of the problem lies with the pupils themselves. There are a number of variations on this latter theme. One of them involves the contention that students are incapable of grasping some of the central concepts contained in contemporary curricula because they have not reached the appropriate level of cognitive or intellectual development. Another insists that science today has become so abstract and complex that it can only be made intelligible to the gifted few - "the brightest and the best". And so on. However, these last two explanations ignore the fact that many otherwise sophisticated adults experience virtually the same sorts of difficulties in attempting to understand certain scientific concepts and theories as youngsters do– as David Hawkins' story at the beginning of this paper makes plain (Hawkins, 1974),

(see also Hawkins 1978, 1982; D. Smith; 1987; Hills, 1989). And, finally, some have traced the problem to the quality of instruction, and from there to the quality of pre-service or in-service teacher education.

For our own part, we are more inclined to look for explanations that begin not by blaming the teacher, the students, or the curricular supports, but by acknowledging the nature and complexity of the task we set for ourselves when we undertake a commitment to scientific literacy for all, especially if literacy is taken to involve coming to understand certain fundamental scientific concepts and principles from the inside. Donaldson (1978), for example, notes that, "some of the skills which we value most highly in our educational system are thoroughly alien to the spontaneous modes of functioning of the human mind" (p. 15). Referring specifically to science, Dewey (1938) observed that: "scientific method as now practiced is too new to be naturalized in experience so as to become an integral part of the corporate belief and attitude" (p. 338). Considerations such as these place our problem in a broader context and provide some important clues concerning a possible solution; i.e., there may well be something in children's normal, "untutored" modes of functioning that serves to create difficulties when they, and adults for that matter, come face-to-face with contemporary scientific concepts and principles. What renders this suggestion plausible is the idea that meaningful learning involves establishing a connection between the learner's past experience and the new knowledge to be mastered. Of course, not all learning is meaningful learning. Some of it "decays" or is quickly forgotten because it was originally grasped in some purely external, rote or verbal, way. Meaningful learning, or educationally significant learning, by contrast, requires the forging of intelligible connections between the learner's present understanding and the framework or system into which they are being initiated (Piaget, 1962; Ausubel, 1968; Novak, 1977; Hawkins, 1978; Petrie, 1981; Posner & Strike, 1982: Strike & Posner, 1985). Both Dewey and Donaldson may be interpreted as suggesting that there might be some sort of fundamental tension or discontinuity between the untutored beliefs or ideas pupils bring to formal instruction and the conceptual schemes into which educators attempt to initiate them. The recent literature on pupils' 'alternative frameworks', 'misconceptions', 'preconceptions', and so, on strongly suggests that something of this sort might well be going on on a number of fronts (Driver & Easley, 1978; Hawkins, 1978; Gilbert, Osborne, & Fensham, 1982; Hills 1989).

If this assessment is on the right track, that is if a significant proportion of the citizens of today are in the dark about science at least partly for these reasons, then

the question arises, what might be done in order to solve the problem? In other words, if a majority of the general public must be judged as "scientifically illiterate" because they have not even begun to understand the basic concepts and principles which inform and govern certain forms of scientific inquiry, and if they subscribe to a view of science as a field of endeavour populated by experts with the "right answers", and if, moreover, large numbers of young people are leaving our schools and universities firmly convinced that science is something which makes very little sense, or worse, that it is something to be feared and avoided– and, in any case, that as a body of knowledge or form of inquiry, it is largely irrelevant to the life of a citizen as we approach the twenty-first century– what steps might be taken to ameliorate this kind of disillusionment, anxiety and suspicion?

As suggested earlier, our efforts in this field have been focused on working with teachers in the elementary school. Our position in this connection is largely sympathetic to the one adopted by the AAAS: namely, that whatever steps are taken to enhance the quality of science education, the teacher must be seen as playing a pivotal role. They put it this way:

> Although creative ideas for reforming education come from many sources, only teachers can provide the insights that emerge from intensive, direct experience in the classroom itself. They bring to the task of reform a knowledge of students, craft, and school culture that others cannot. Moreover, reform cannot be imposed on teachers from the top down or from the outside in. If teachers are not convinced of the merit of proposed changes, they are unlikely to implement them energetically. If they do not understand fully what is called for and have not been sufficiently well prepared to introduce new content and ways of teaching reform measures will founder. (p. 155)

The primary goal of the project described below has been to develop a program of in-service education to meet the special needs of elementary teachers working at the K to Grade Six levels.

II. "THE SCIENCE CLUB": A PROGRAM OF IN-SERVICE EDUCATION IN SCIENCE FOR ELEMENTARY TEACHERS

A. A Brief History of the "Science Club"

In 1986, in response to the recommendations of the Science Council of Canada (1984), the Ontario Ministry of Education undertook an ambitious program of reform

aimed at supporting, "...the renewal of Primary and Junior science education in both English- and French-language schools in Ontario." *(Science in primary and junior education: A statement of direction*, 1986, p. i). The plan of action consisted of twenty-four initiatives organized under such headings as: Curriculum, Support for Teachers, Equipment and Learning Materials, etc. Under the rubric of "Support for Teachers", initiatives focusing on the development of new approaches to in-service education were given high priority. The project described below, which has since come to be known as "the Science Club", was funded under the Ministries' Innovative In-service Incentive fund. Matching funds were provided by two local school boards; namely, the *Frontenac County Board of Education* and *the Frontenac, Lennox & Addington Roman Catholic Separate School Board*.

The authors of the original proposal, Farquhar and McAndrews (1987), also became the principal instructors/coordinators in the first two years of the project. The third member of the organizing group, Hills, is an external evaluator of the program. His role is that of a participant observer whose responsibilities involve: taking part in all the in-service sessions, keeping a diary of significant happenings, conducting interviews with the participants, including the coordinators, at various stages during the program, and organizing other evaluation activities for the members of the Science Club.

Early in September of 1987, invitations were sent to the Elementary principals in the two local school boards asking them to identify one or two teachers who would be interested in participating in a program of in-service education in the field of elementary science. For the first two years, the group of forty teachers who responded to this invitation was made up of a roughly equivalent number of Primary (Grades K to Three) and Junior (Grades Four to Six) teachers. This year, at the request of the sponsoring boards, membership in the program has been allowed to grow to seventy-five teachers and the range of activities has been expanded to include elementary mathematics.

B. Aims of the Project

The principal aim of the project was, "To raise the comfort level of teachers with science and the teaching of science..." (Farquhar and McAndrews, 1987, p. 1). The notion of comfort or comfort level as it applies to science teaching is an especially slippery one. But it has, nevertheless, turned out to be a very useful one for helping teachers talk about their attitudes towards science. Some teachers who described

themselves as being uncomfortable with science indicated that they felt they lacked the ability or aptitude for learning science and, hence, for teaching it. Others, because of their experience in high school courses, had developed an attitude towards science that might be described as one of "fear and loathing". Those who expressed this view made it plain that they saw little point to 'memorizing all those formulas and equations' which are, after all, irrelevant to "real life" problems. Still others indicated that, while they enjoyed science-like activities out of the classroom, they were uncomfortable because they were uncertain as to whether these activities were acceptable as part of the science curriculum (It's fun! But is it science?). And, there are other teachers whose discomfort seems traceable to the conviction that they don't know enough science to answer all of the questions their students may raise about a given topic. So the aim of raising comfort level, while it may appear to be relatively simple at first glance, turns out on examination to be a good deal more complex including such things as confidence in one's ability to learn, in one's knowledge of the subject matter, and in one's understanding of the nature of science and of scientific knowledge– i.e., of what does and does not count as 'science'. It also involves the need to feel assured that particular items of the subject matter are worthwhile– are apt to be interesting to and provide beneficial experiences for the learner.

In attempting to understand some of the difficulties students encounter in learning science, Hawkins (1978) has introduced the notion of a 'critical barrier'. Critical barriers are roadblocks to science learning that grow out of a cognitive conflict between elementary scientific ideas and the conceptual schemes of commonsense. Thus, for example, the scientifically naïve typically bring to instruction commonsense ideas of an animal, of heat, or work which are in some sense incompatible with their scientific counterparts and may well create barriers to further learning. What we wish to suggest in this connection is that our preliminary explorations of 'comfort level' have begun to turn up a new class of critical barriers. Indeed, based on our experience thus far, we are persuaded that under the heading of "comfort level", students are faced with a variety of obstacles to learning science (and to teaching it) that are every bit as significant and challenging as those Hawkins has described. Yet, unlike the class of barriers associated with conceptual or cognitive conflict, barriers associated with 'comfort level' inhabit and arise out of conflicts in a somewhat different realm; namely, the domain usually referred as that of the 'affective' or 'expressive'. Perhaps the most important point to be made here is that, in one important sense at least, critical barriers of this latter kind are prior to and take precedence over those of a cognitive sort. For unless, the learner develops some

minimal confidence in their ability to make sense of and to learn the relevant scientific concepts, e.g., of heat or light, it is unlikely that conflicts of a cognitive sort will emerge.

The more general point is that the project began with a number of aims which can be grouped (more or less "comfortably") under the heading of "raising comfort level".

C. Context of the Project: Activities and Assumptions

Based on their wide experience both as teachers and as consultants working with teachers in the elementary school, the instructors were well acquainted with the kinds of expectations (and aversions) the participants were likely to bring with them to a program of this sort. Accordingly, they set out to design a flexible program of activities, centered around 'hands-on' science, that would be readily adaptable for dealing with these varied sources of discomfort.

The broad format of activities for this program of in-service education for the past two years has been as follows: During the first year the group convened for a total of sixteen sessions. Eleven of these, 7 three-hour meetings and 4 one-and-one-half hour meetings, were working sessions conducted either by the instructors or by guest speakers. Two all-day workshops were organized by Frances and David Hawkins with the help of Maya Apelman[1],– one for Primary Division teachers, the other for teachers in the Junior Division. The first year of the project concluded with three sets of small-group interviews of the teachers involved in the project carried out by the participant observer. The venue for these activities alternated between the teacher centres belonging to the two participating school boards. In the second year, the activities of the Science Club consisted of eight three-hour meetings held once a month beginning in October and ending in May. In March, teachers were released from their normal teaching duties to attend two all-day workshops, one for the teachers in each division, which they themselves organized and presented. The second year's assessment was conducted by inviting teachers to write about their experiences in the Science Club.

In order to encourage greater group interaction, and out of respect for important differences in their professional interests, the instructors divided the teachers into two working groups– one group consisting of Primary Division teachers (i.e., Grades K to Three) and the other of Junior Division Teachers (i.e., Grades Four to Six). One instructor worked almost exclusively with the Primary Group, while the other worked

with the Junior teachers. In the early sessions, it was typical for the instructors to select a topic, such as colour and the mixing of colours, light and shadows, or the senses, to bring in materials associated with that topic, and to begin the evening by demonstrating a number of different 'hands-on' activities of a sort that the teachers might ultimately try out in their own classes. Normally, different activities were chosen for each of the concurrent sessions. So, for example, on the evening when the Junior teachers were doing colour and the mixing of colour, the Primary teachers did the senses.

The next stage in these sessions normally involved providing the teachers with the opportunity to investigate ("mess about", or play, with) these materials. Accordingly, following the "demonstration", each of the larger groups were sub-divided into smaller working groups, involving about three or four teachers. These smaller groups worked at centres furnished with the same materials as those used by the instructors in their demonstrations. On some occasions, they were simply invited to "mess about" with the materials– e.g., "try mixing the different colours of paint and see what you can discover". On others they were presented with a (usually open-ended) task, or challenge such as "How can you build a bridge strong enough to support such and such an object using only newspapers?".

Evenings would frequently conclude with a discussion ranging over such topics as the varied investigations the teachers had carried out, what they had learned from their explorations, their views of the advantages and disadvantages of trying out these activities in their own classrooms, how these activities might be adapted to suit the special features of different teaching situations, and where one might obtain suitable materials. Later in the year, as some teachers began to use these activities, evenings would begin with "sharing time". During this phase of the meeting, the whole group, both Primary and Junior Division teachers, spent a good deal of time discussing different aspects of these activities including; students' responses to them, what came to be referred to as "extensions" of, or variations on, these activities, possible sources of materials, and a variety of other issues related to doing this kind of science in elementary classrooms. The scope of discussion topics broadened even further in the second year as some teachers brought in new activities they were designing and trying out, and as others began to videotape lessons carried out in their classrooms and share the tapes with the group.

Throughout, the instructors made a deliberate and sustained attempt to avoid creating among those participating the feeling that they were under an obligation to try out the activities demonstrated or discussed in these sessions. Rather, the tone

was one that suggested that central to any decision to try something out was the teacher's judgement that the activity was appropriate to his or her situation, worthwhile, and, above all, something with which he or she felt "comfortable".

The structure and content of the program, as well as the atmosphere the instructors worked very hard to create and maintain in these sessions, grew out of a number of interesting pedagogical commitments or premises. Given the limitations of space, we can only consider one or two of these here (a more detailed account of these assumptions is developed in Hills, McAndrews & Farquhar, 1988). We will briefly outline two of the assumptions that help to explain why the program is organized in the way it is and that draw attention to some of the distinctive features of the Science Club as a program of in-service education.

D. Farquhar and B. McAndrews (1988) describe one of the innovative qualities of the project as follows:

> We believe that an autonomous investigative approach is vital to pupils' scientific learning. We also believe that this is true for teachers' professional learning. Individual teachers will effect lasting (personal and professional) change if allowed to use an investigative approach in learning the science they might eventually to decide to use in their own classrooms. (personal communication, May 17, 1988).

Now it is in its underlying views of teachers' professional learning– namely, that it is similar in important respects to children's learning– that we begin to catch the distinctive flavour of the program of activities undertaken in this project. Until quite recently, it has been commonplace for curriculum designers and developers in the field of education to think of an undertaking of this sort largely as a matter of changing the teachers' behaviour. Of late it has become fashionable to speak about altering teachers' "thought processes". Both of these visions of educational reform have flourished under the banners of 'curriculum innovation' or 'curriculum implementation'. We have deliberately avoided this language choosing, instead, to refer to our program of activities as an exercise in 'teacher education', one of the implications being that a fundamental goal of the undertaking is to "...enhance the competence and extend the independence..." of those involved (cf, e.g., Hawkins, 1973). If teachers do come to do things differently in their classrooms, they must choose to do so, and this in turn requires– if the choice is to be an intelligent and rational one– not only that they learn new reasons for acting but also that they learn to act in new ways– all of which involves considerably more than mere changes in behaviour or alterations in thought processes. The main point here is that, if we

think that an autonomous investigative approach has an important part to play in children's scientific learning and if we aim to help teachers come to understand the benefits, and limitations, of this kind of learning, teachers themselves must be given the opportunity to learn in this way. Too often programs of professional development, or advocates of curricular reforms, have attempted to persuade teachers of the virtues of such an approach merely by telling them about it (backed up by suitable visual aids and further things to read) and exhorting them to try 'it' out in their own classrooms. Of course, all of this has been done in the complete absence of any more than a token opportunity for teachers to experience this approach to learning first-hand.

From the outset, therefore, our thinking has been informed by a very different view of the enterprise sometimes referred to as 'curriculum change' or 'curriculum implementation'. (This is why we feel a twinge when, after apparently moving the teacher to the centre of any initiatives aimed at the reform of the science curriculum and acknowledging the dangers of "top-down" or "outside-in" proposals for change, AAAS (1989) promptly lapses back into the language of implementation, (p. 155),

Thus when we speak of an "autonomous investigative approach" in the context of teachers' professional learning (or of children's learning) it needs to be interpreted against this background (cf. also D. Hawkins, 1965, & S. Rowland, 1987). It *does not* mean that pupils are simply handed some materials, and then left completely to their own devices– in the manner reminiscent of certain early versions of 'discovery' or 'inquiry learning' which appear to be modelled on some variation of Baconian induction (cf, Dearden 1968, 1976). Rather the implication is that, when students are provided with the appropriate materials and invited to engage in these sorts of activities, they will be given more freedom to control the direction of the activity– i.e., the questions to pursue, the avenues to explore, the hypotheses to test, and to determine it's outcome than they would normally, for example, in 'direct instruction', teacher-directed discussions, or conventional demonstration lessons. At the same time, however, certain things about the way the situation is structured help to insure that these explorations are not blind or unproductive. To begin with, the teacher usually offers some sort of guidance if only by saying something such as, "Today we are going to learn about light", or "See if you can figure out how to...". Second, in the unlikely event that no direction is forthcoming from the teacher at the outset, the materials themselves create, and the students bring with them, the expectation that the activity is to have some sort of scientific import. Moreover, if the import is not immediately obvious, it usually emerges in the very rich social interaction that typically abounds in well-organized versions of these activities. And, finally, let us not

forget that, when classes are organized in this way, the teacher is available to answer questions, make suggestions and in general to offer judicious guidance to the students[2]. In short, central to the notion of learners' (whether child or teacher) autonomy, is the notion of choice, decision or judgement. The principle here is not all or nothing. Rather it is one of "degrees of freedom" in reference to certain kinds of activities.

III. THE FIRST TWO YEARS OF THE SCIENCE CLUB: AN ASSESSMENT

The concluding section of the report explores some of the ways in which participating teachers have responded to the project focusing particularly on their comfort level with, and their insights into, science and the teaching and learning of science. From the outset, we were convinced that in undertaking this work we would learn as much from the teachers about the art and craft of teaching young children as they would about science and the teaching of science from us. Nevertheless, we must admit that were surprised at some of the recurrent themes which emerged time and again in informal conversations, interviews and the teachers' writing. Without question they have helped us to see this type of in-service work in new and exciting ways. They have inspired us to do a great deal more talking, reading, writing and research– in a word thinking and learning, than we had originally expected. From all of this one thing has gradually become clear: namely, that given adequate time and a supportive environment (viz., a community) where people are willing to share their triumphs and failures, their fantasies and frustrations, their anxieties, their ignorance, and their misapprehensions, and where other members of the community see these not as faults or defects but as growth points for new learning and inquiry, these elementary teachers, likewise with little in the way of formal preparation in science, were much more capable engaging in scientific inquiry and in helping students in their classrooms to do the same than either the conventional wisdom about school or the national reports cited earlier would have led us to expect. We sometimes wonder what might have happened to the reforms of the '60's, i.e., E.S.S., Nuffield Science etc., if teachers had been given these kinds of opportunities. It is equally interesting to think about why they were not.

A. Assessment Strategies

Two different approaches have been used to assess the project thus far. At the end of the first year, 1987-88, a series of three small-group interviews were carried out by the participant observer each lasting about two hours. To conclude the second year of the program,1988-89, participants were invited to write about some significant aspect of their experiences in the Science Club. In selecting these two approaches, we considered and then rejected two other alternatives; namely an end of course questionnaire and on site classroom observations. The decision not to survey the participants by means of some sort of formal, written questionnaire was based on two considerations. First, and most important, was the fact that the purpose of the evaluation was to try to understand the impact of the project in the teachers' own terms. The very structure and terminology of a questionnaire reflects the perspective and concerns of those designing it rather those who are asked to complete it. Those responsible for interpreting the results are typically required to make untested assumptions about how those completing the questionnaire have interpreted the items that make it up. In other words, as typically administered, those interpreting the results have no opportunity to probe the thinking of those responding in order to determine (1) how they interpreted the questions, and (2) what they meant by their responses. We ruled out classroom observation as a way of gathering information for the evaluation because, based on our conversations with these teachers, it would have been too invasive and disquieting an approach for many of them who are just beginning to explore new ways of doing science elementary children.

While it was decided not to use a formal, written questionnaire, it was, nevertheless seen as important to canvas teachers' views concerning certain features of the project and the circumstances under which they came to participate in it. In consequence, during the first year a lengthy list of questions was initially drawn up and subsequently revised a number of times in consultation with the instructors and with the Hawkins' and Maya Apelman. Prior to settling on a series of small-group interviews with teachers in the Primary and Junior Divisions respectively, two alternative ways of using these questions were considered. One was to simply invite students to complete and end-of-course questionnaire– as is frequently done. This was rejected for the reasons noted earlier. The second alternative involved a two stage process. The first stage would have consisted of a set of two, one and one half to two hour, round-table discussions– one each with the teachers in each division. The purpose of these discussions would have been to invite the teachers in each group to

reflect on their experiences in the program and to suggest ways in which the questionnaire could have been revised. Following this, a second stage would have consisted in identifying a small number of teachers in each division and interviewing them separately using the revised set of questions. This alternative was set aside primarily because it would have required some of the teachers to be away from their classrooms twice during the month of May which, by their own accounts, is normally a very busy time for them. A second and equally important reason was that small-group interviews could provide the kind of forum in which participants could share experiences, and draw on the insights and encouragement of their colleagues in talking about what the project had meant to them, how next years' program might be improved, and so on. In short, it would provide them with an opportunity to reflect on their involvement in the Science Club and to compare what they had learned with others.

Consequently, a set of two small-group interviews were scheduled, one for Primary and the other for Junior Division Teachers, for May 26th and 27th 1988 respectively. Shortly before these interviews were held, two Primary Division teachers who wanted to participate indicated that they would be unable to attend either of these two sessions. In order to accommodate them a separate session was arranged for May 25th. All the teachers in the project were invited to participate in the interviews and informed that if they chose to do so funds from the project would be used to hire a supply teacher for the afternoon so they could be released from their normal teaching duties. In all 14 of 16 Primary Division teachers (87.5%) and 15 of 21 Junior Division teachers (71%) participated.

In conducting the interviews the participant observer had two main goals in mind. The first was to establish an atmosphere that would encourage free and open discussion of all facets of the project regardless of whether the assessments were positive of negative. The second aim was to explore teachers judgements concerning certain aspects of the project so as to begin to reveal the thinking that lay behind them, and to portray those judgements– as far as possible– from their own point of view. The most appropriate form for this kind of discussion is what R. S. Peters (1968) has described as 'conversation'. According to Peters,

> Conversation is not structured like a discussion group in terms of one form of thought, or toward the solution of a problem. In a conversation lecturing to others is bad form; so is using the remarks of others as springboards for self-display. The point is to create a common world to which all bring their distinctive contributions. By participating in such a shared experience much is learnt, though no one sets out to teach

> anyone anything. And one of the things that is learnt is to see the world from the viewpoint of another whose perspective is very different. **(p.13).**

Accordingly, teachers were sent copies of the questionnaire together with a covering letter explaining the purposes of the interview (both of these are included in *Appendix A*). This was done to give them insight into the kinds of issues the participant observer was interested in pursuing and to afford them an opportunity to reflect on these prior to the interview.

In the second year, a different tac was taken. This time we invited the teachers to write about their involvement in the project on the assumption that the activity would, first, enable them to explore, clarify, and test their own thinking about their experience in the Science Club to date and, at the same time, provide information that would be valuable in the assessment of the second years' activities. Accordingly, at the Club's April meeting, teachers were given a handout entitled "The Science Club: Writing Activity" (*Appendix B*) inviting them to write about their experiences during the first two years. The document explained the purpose of the exercise, how the information would be used, and suggested a number of topics on which their writing might focus. Samples of teachers' writing drawn from the current research literature was included to illustrate ways in which this task might be approached. They were encouraged to use a format they felt comfortable with including a letter, an essay. or point-form notes.

In conducting both assessments the object was gain insight into the teachers' responses in five main areas relevant to the project and its purposes. These areas were: (1) their reasons for becoming involved in the project and what they expected to gain from the experience, (2) their view of the project itself– its' aims, format and content, (3) their judgements concerning the impact of the project on such things as; their personal and professional relationships with members of the Science Club and other members of the community, their understanding of children and learning, and their approaches to teaching and learning science, (4) their view of the overall significance of this project in relation to the full range of recent initiatives taken by the Ministry of Education in Elementary Science, as well as in reference to other developments taking place in the policies and programmes which affect th elementary school.

The results of the first years' interviews are presented Section B below. Rather than presenting the very lengthy interview transcripts *en toto*, excepts have been chosen from them. These are presented as vignettes which attempt to capture both

the content and tenor of the conversations surrounding topics of particular concern to the evaluation of the project. In order to maintain continuity of focus these vignettes have been organized under headings, and in some instances subheadings, that bear directly on the five main areas of concern in the assessment.

The teachers' writing done as part of the evaluation of the Science Clubs' second year is presented in its entirety in Section C.

The names of the teachers appearing in both the interview excerpts and the writings are pseudonyms.

B. Vignettes from the 1987-88 Science Club Interviews

Preliminary Notes and Explanations

As mentioned previously, the names of participants in the discussions which follow are pseudonyms. The expression '(Int.)' has been used to refer to the interviewer and '(R)' to an unidentified speaker.

In keeping with the aim of capturing the teachers' voice, a number of steps have been taken to preserve, as far as possible, the conversational integrity of the excepts presented below. These vignettes have been excerpted from three separate small group interviews held on three different occasions. Accordingly, each comment, or conversational exchange, is identified by the interview from which it was taken by use of the following abbreviations:

PT(A) – Primary Teachers Interview Number One
PT(B) – Primary Teachers Interview Number Two
JT – Junior Teachers Interview

Each identification is followed by a page number which locates the passage within the original interview transcripts, e.g., [**JT, p. 15**]. This may help the reader of the report to gain some appreciation of where, in the overall interview, a particular conversational sequence occurred. During these interviews, as in normal conversation, it was common for topics to spiral back on themselves at some later point. By attending to the page references the reader will be able to determine when this has happened. In order to further portray the continuities and discontinuities in what was being discussed two additional devices have been adopted. When there is an

uninterrupted discussion of a topic or theme with one speaker following another, the comments or utterances have been single spaced. Where there is some sort of break in the flow of discussion, this has been signified by double spacing. The interview identification codes together with page number(s) mark the end of a comment or an uninterrupted segment of conversation. Moreover, the responses have been roughly catalogued under a number of headings, drawn from the questionnaire that guided the interviews, and the responses on a given theme have been further separated by a '*********' to indicate that they are taken from the transcript of an interview different from the one that precedes this symbol. And, finally, where there may be more ambiguity than usual concerning the question that has prompted the ensuing discussion, the original question posed by the interviewer has been included in bold type.

Introduction to the Interviews: Setting the Stage

(Int.) People take that [pointing to questions that were mailed out to teachers] as a questionnaire, and that's not how it's meant, either. But you know it's just– **here are five areas: why did you come into the project (roughly)? what did you make of the project– what kinds of things did you see people doing? what did you get out of it? And then, how do you see the overall thing in the first place, sort of in the context of all the other kinds of things the ministry is doing and trying to do in schools, with in-service, with new curriculum documents?** [PT(A), p. 1]

1. Reasons for Becoming Involved in the Project

(Int.) How did you each first learn of the project?

(Int.) **Well, WHY did you decide to come along, then? Or, once you had heard about it, why did you think it was an important thing, or something worth doing? Something you wanted to do.**

(Sue) Doug really sold me on it because– well, actually, when I first heard about it– I actually heard about it last year at about this time– that there would be some things, and then Doug and Sheila and I had a meeting at the Science Council when I was really supposed to be putting on a workshop– at the end of last summer. And I got really enthusiastic about something, and Doug said, "This is– you should be part of this course because it's for people like you who are interested but unsure of yourself." (Int.) Yeah. (Sue) And this is the way I've always felt. Even though I've written materials of my own, I've always been unsure because there's always been that "I don't have all the answers", and "Am I doing this right when I present this?" Biological science where you study animals is easy, but a lot of the mechanical and physical– you know, is it okay just to play with bubbles? I

love playing with bubbles! Is that okay? (Int.) Yeah! (Sue) That's another thing: I needed permission from somebody to DO those things that I wanted to do before I felt comfortable in doing them. And so Doug said that this thing was going on, and I really thought, "Well, I've taken Science courses; I've taken Ministry courses", and I thought, "Oh, is this going to be another one but maybe it'll be important. Maybe it'll reinforce what I know or renew what I know because this is my first time in a classroom for a long time". And then when I started going I found it was doing more than that. It was not just reviewing what I needed to know, not just reinforcing that this is what you teach at this grade level, etc., etc., but HOW. And how to get the kids actively involved. [**PT(A), p. 4**]

****

(Nancy) Well, in my case, we'd been working on curriculum units in science. Our principal had worked with the draft document a lot, and so we were thinking along the lines the draft document had laid out. So that sparked the interest. And when she suggested that I might like to come, I was very enthusiastic.

(Margo) At our school, we have a teacher on the staff who's a science contact in a way. Any science information that comes through the school filters through her, and she talked to– approached– a couple of teachers in our school– one in the junior and me in the primary– because different things that were happening in science in the school, and different workshops that were coming up– we'd shown an interest so she asked us if we wanted to participate.

(Jean) I came because I felt that science wasn't one of my fortes and I thought that by participating I would improve my science ability and then improve my lessons.

(Hazel) .... But my reason was because I felt like this lady over here– I needed a lot of experience in science and I didn't feel that strong teaching it. Now– I enjoyed it immensely, and I learned a lot about groups, working in groups, and recording graphs and things that you can do in science.

(Nancy) I knew, from looking at the early drafts of the document over the last year and a half, that they were saying very clearly that children would have experience in life sciences or space sciences and physical sciences–and I felt, myself, and I think that other primary teachers sometimes share the belief that we're pretty comfortable in the life sciences and maybe a bit more so in earth/space, but when it comes to physical sciences, forget it! And I really didn't know how to build into my program those things that are the physical sciences– those things with light and pendulums that the Hawkins– all of those things! I wouldn't even have thought of it! And because I teach a lot by the theme method, I don't know how to build those things in because they're not part of my experience, and I think you have to THINK about it first before you can get it there. And it's so easy for me to build in life sciences because that's part of my– well, just what I am– things that I've done. But I don't KNOW anything about these other things and I thought maybe that would be very helpful, to be part of this sort of thing. And it has been.

(Betty) I think that the main purpose I got interested in it was getting some ideas on how you get teachers turned on to starting with science and moving outward from that into the process, rather than starting with language.

(Marnie) And I just think ...– even if you ARE fairly comfortable with most sciences, as Nancy was just saying, the physical sciences often pose a problem. And even if you're familiar and comfortable with science, the things that we've been exposed to can't help but be beneficial. And for that reason it's worth pursuing. **[PT(B), pp. 4-6]**

(a). Hopes and Expectations

(Int.) **What did you expect to get out of the experience? You know, what kinds of expectations did you come to the session with? You've said a fair bit about them already.**

(Molly) I expected much more theory and, of course, it's the getting involved with things that give you the experiential background to boost your confidence to try things in the classroom. And until you work through something yourself you don't know what the pitfalls are. And I wasn't expecting that at all. And I think that, to me– that's the be-all and the end -all!

(Int.) How about you, Sue? **What sorts of expectations did you have on coming in?**

(Sue) I thought there would be more of an exchange with the teachers. I think we're all still a bit shy. I think that's one of the reasons why people strongly suggested that they start again next year with the same group of people. It's just NOW that we're getting to know each other and to feel comfortable with each other, and– (Int.) Your trust level is beginning to come up a little bit, yeah. (Sue) Right. (Molly) Yes. People are much more spontaneous, now, I think. (Sue) You can fail. Say, "I failed. But this is what went wrong." And people you know you are with a group of friends who aren't going to be critical of you. People ARE admitting that they've failed, and that this didn't go as well as they planned, but they know what they're going to do next time. I think that's going to be a good thing next year when we start. **[PT(A), pp. 9-10]**

****

(Ann) I think I came in very open-minded, expecting to learn and work in a small group which was really appealing, but I really didn't know what to expect.

(Hazel) I was anxious to see what other teachers were teaching at a primary level in their classrooms,... **[PT(B), p. 7]**

(Penny) Well, I didn't have any, other than to just learn. As a relatively new teacher I'm eager to take as many different kinds of workshops because I find this is how I learn my curriculum, and the idea of getting to know what other primary teachers are doing in the area of science... **[PT(B), p. 9]**

****

(Terry) I think that ought to be in our own system, in fact myself included, we actually thought it was going to be a writing project, a follow-up to that course that was sent down– that outline that was sent down a year ago. And that's why– so we were rather surprised that–

(Int.) So you came thinking you were going to write some curriculum this winter?

(Terry) That's right. **[JT, p. 4]**

(Phil) Well, after attending the science workshop in science, and seeing Paul and some of the other people put on presentations, and talking to Doug and being assured we would NOT write curriculum, I thought it was going to be a hands-on type of thing we could take back to the classroom which would be useful almost immediately. That's why I decided to participate in it. **[JT, p. 4]**

(Connie) Well, being a first year person teaching Junior Science, of all the years that I've taught I've never taught Science, when I first heard about it, and knowing the new curriculum was coming down, I thought we were going to move through the curriculum and develop corresponding units– hands-on things and that sort of thing. So I did think there would probably be some writing what was involved. I think our principal, it seems to me somehow– I can't remember if I heard from another school or from our principal– came to people who had expressed an interest in Science and said, "Now this is available: would you be interested in being a school rep to go?" And wanting to get some ideas in Science at the Junior level, that was one of the reasons I said "yes". **[JT, p. 5]**

(b). Reservations

(Int.) **Did you have any reservations about any sort coming in? What I'm asking that for is that people saying, you know, this whole business about comfort level.**

(Nancy) I think you always wonder if the people who will come will be experts in science, and YOU'RE going to be the one who looks so foolish, you know. I'm sure that's always part of the experience when you come into something.

(Jan) I guess I came wondering if anything would be guaranteed formula. I didn't realize how much science I was doing until I got here.

(Betty) Yeah, I think that's one of the things– I felt SO isolated because I do have some science background, I didn't see a lot of it happening, and I'm saying, "I'm doing this; nobody else seems to be doing it– maybe I'm doing the wrong thing!" Nobody seemed to say one way or the other what you were doing was right or wrong, or whatever, so you go sort of fishing in the dark and when you get together with a group of people you find out, well, hey, things aren't bad at all– your ideas weren't so bad– this idea wasn't so good, throw it out– try this idea– you know– it's good to get the kind of positive feedback that you wouldn't. You feel isolated. **[PT(B), p. 9-10]**

****

(Sandy) One thing that they told me before I joined up was that I had to be videotaped, and I had visions of a whole team of people running around with cameras and lights, and so I was a bit doubtful about that! [**JT, p. 5**]

(Connie) I think I had reservations about my science KNOWLEDGE. Even though we're talking about a junior division, having not done it and not done science for quite a while, there were things that I was comfortable about, but there were a lot of things that I WASN'T comfortable with, and that's why, when we worked through certain things, it was– you know, I gained a lot more out of it than just people presenting things and sort of very short and crisp and whatnot. I had to work through them myself to feel that I would be comfortable to use them in the classroom. When I first came, you know, there was that "Do I have something to offer this group?" I really came to GET something out of this; I didn't come hoping to "give" because I didn't think– in science– that I had a lot to give. So I came hoping that people are going to give ME. (Int.) Okay. (Connie) I was willing to put in the man hours because I've done that before and found that you do learn an awful lot, but that's really what I was coming– to take more than I was going to give.

(Linda) Connie, I think you gave a LOT! (inaudible)

(Connie) Well, I think, if I GAVE, it's because I wanted things spelled out so that maybe other people wanted the same as I did, and I– maybe I persist until I get what I want, [laughter] I don't know, but that's the level that I was coming from and feeling that I needed. So if other people felt that– but I did come UNCOMFORTABLE at the beginning because there WERE people who have taught intermediate science, and you bounce these, "Oh, yeah! Sure, sure ..." and I'm sitting there, you know. So–

(Int.) Not knowing how much other people knew,–

(Connie) That's right.

(Int.) –and what THEIR concerns were. [**JT, p. 6**]

(Int.) .... **– did many people feel uncomfortable with teaching elementary science and, if so, what kind of discomfort? You know, what was the basis of your discomfort with doing it?**

(Seth) I think a large part of the discomfort would come from the lack of materials, especially in the elementary classroom, whereas I think that was one of the benefits of this program. It showed us how you can do science with kitchen materials– "kitchen chemistry", as it's called. You don't need your science– full science cover– you can improvise and yet, at the same time, be able to teach them the same scientific principles.

(Int.) Okay. Other sources of discomfort that people felt?

(Alice) I didn't feel uncomfortable with– like, I never have felt uncomfortable with the content part of the science, but again, we'd always like to have more by way of materials in the classroom, and that's one thing I enjoyed about this project was that we had a lot of active, learning type situations where we were working with materials from different sources. We didn't have anything in the way of "print" materials; you weren't reading, you were doing things all the time and, even if you didn't know a lot about what you were playing with, you learned something– you knew you were doing science– something specific that you had to learn was quite often open-ended and you felt that you WERE learning and you could see where the children would enjoy doing the same kind of things.

(Phil) I guess I was worried that the Ministry and all the documents and philosophy coming down are supposed to be child-centered and a lot of integrated activities with a lot of language development, and I was afraid that the science– the way it MIGHT happen would be a very segregated type of thing that you do just with science. But the way this whole workshop was put together, we had a chance to talk with each other while we were playing with the equipment and discover how much language takes place, and there really is a child-centered approach. And for ONCE, I found it's not only a document, but this workshop shows you how to do what the Ministry has been saying for the last ten years. And I really liked going through the same activities the kids do because, once you've done them yourself and see that they ARE child-centered, I just feel much more comfortable going back to the classroom. And people here I found were very easy to talk to. And I was comfortable after the first night because people– I think we were all in basically the same boat. We had a few theories that we didn't have enough background, but it didn't take too long just to go to anyone and sit down and ask questions. Someone in the group always had the answer, or at least when it was very close we could take the news.

(Int.) So, shortage of resources is one source of concern, and then just not knowing how kids would react to some of these activities– is that part of it, or– ?

(Phil) Yeah. It's not necessarily how children would react but that the Ministry would write a document and do a workshop and present, totally in opposition to how the document was written. Like, I agree–

(Int.) That's happened before, in your experience?

(Phil) Yes. That they tell you one thing but then when you go to the workshops they lecture and they do just the opposite of what they're telling you, the teachers in the classroom, to do. And this was set up to teach you and show you how to do exactly what they were preaching. And I count it very beneficial from that point of view.

(Int.) Okay.

(Alice) I never felt– like, I've never felt in teaching science that it was really that we were short of resources. You're usually more short of time, or don't take the time to round up materials. Because, when you take a look at the new document and find that Science is Happening Here, you really don't need that sophisticated of materials. Most of the things you can acquire at home

or at *Canadian Tire*. It's just having the time, or taking the time, to organize it and set it up. **[JT, pp. 6-8]**

2. What Did You Make of the Project Itself: Its' Content Format and Goals?

(a). Likes and Dislikes

(Int.) **....You've talked about your hopes and expectations for the project. In a way, these two questions, if we look on part two on page three, what did you like MOST about the project? (We've kind of talked about that already.) And why?**

(Debbie) The fact that you could use a lot of equipment which was easy to get. **[PT(B), p. 14]**

(Jan) I think what I liked, too, was just the fact that it WAS a non-threatening atmosphere--kind of. I just felt quite comfortable with talking, and not too much was expected one way or another. Just the way everything was conducted.

(Int.) So you didn't feel any pressure to do– (Jan) No Just to learn. You know. (Jean) And you didn't have people, like Maya was saying,"when someone starts out saying 'Obviously, this is the way such-and-such works,'" when it ISN'T obvious to you at all. (Int.) Maya was saying that? **[PT(B), pp. 18-19]**

(Jean) Yeah, she said when someone starts out, "Obviously, this is the way an electric magnet works," and you're going, "Oh? Well, why isn't it obvious to me? I must be dumb!– with my background in science". But I didn't find it threatening at all.

(Nancy) I also think it's been great to have both Brian and Doug involved, because you were saying that you pulled from both of those resources. But I don't know how they do it. I don't know how much release time either of them can get. I don't think they get a lot. (Int.) No. (Nancy) Well, that's what I was expecting, and I don't know how they do what they do, and yet they're a fantastic resource for this kind of thing. **[PT(B), pp. 18-19]**

(Nancy) One of the things that I REALLY have– it's been very interesting. First of all, most of us are female, and we have wanted kids– especially girls– to be interested in math and science. And here we are messing around with these things, and we want our kids to be interested in them, and maybe if you could bring that enthusiasm back without even planning it or thinking about it, the girls in the classroom will pick up that interest and enthusiasm. And I think, if we do that, isn't that wonderful! That was one thing I thought about. **[PT(A), p. 27]**

****

(Int.) We've already started to talk about this, but if we move into the area about the project, let me just raise the question of **what you liked about the project the most.**

(Terry) The hands-on approach where you're working with the materials, whether they were commercially made, and there were very few of those– most of them were made available to all of us. And as I've said, we could branch out, given any starting point, any one of us could think– still could think about an activity, whether throwing with the balls or whatever, you can think of a dozen more yourself, so if you've got a class of 30 children they're able to share and they think of that many again. **[JT, p. 11]**

(Don) I like the idea of sharing– each of us coming in and with different aspects of the same thing. And, at least if it's an extension in a sense, we can look at the same thing in so many different ways and it's enriching. It makes it so much better. **[JT, p. 11]**

(Mary) I think the comfort level improved as the year progressed, as people got to know each other better, and I think that's why we can say now we'd like to share some more. And one other thing that's happened as well is that Brian and Doug were so good to give FREE things to us like this *Science Is* book, what a way to initiate, you know–

(Alice) Did they come from the Ministry were they funded by the Ministry?

(Mary) They were funded by this course. So when you think about these tubes. And getting the mirrors, and things to sort of help us to try out some of these things .

(Sandy) Once I got the mirrors, I did a whole unit on light and reflection, and I probably wouldn't have if I'd had to find them myself. **[JT, p. 11]**

(Int.) **What did you like least?**

(Molly) There wasn't enough time.

(Sue) And I think what people said was very reasonable. Some people wanted this stuff written down, even if it's just written in point form to remind them. You don't need a whole unit written– four or five pages with your aims and objectives– but just a summary of all the activities that you had that day. (Molly) That's right. (Sue) And the materials needed. So that when you pick it up that's when the– (Molly) The space and material is very important, I think. (Sue) The science class, because everyone will have the materials that you're needed right there. And the kids could even do it themselves if you'd just find what they needed and go and get them. And I think, when you're doing that, some people suggested– other people didn't want to spend the time on it– but us people with weak visual memories would really like to go through that again, and have it listed it down, or have someone summarize those things that we did so that what I'm going to do– like, I don't have to try to remember, and I have several activities there. Because I KNOW I'm going to do it now. Because I can't

do an activity with just a small group. It has to be– everybody has to be active all at once.

(Molly) That's right. That's one of the problems in the classroom, I think. Even when I did one of the 'sense' activities where the kids had to smell the different things, and they were in pairs– oh, it took them DAYS to do it because they were going in pairs because I didn't have enough for everybody to do it at the same time. And they took forever! (Sue) The other thing I hated was being split from the primaries. There was so much left. Both of us are doing– (Molly) We felt as if we were both losing out or missing something. (Int.) And you wanted to see what the primaries were doing? (Sue) I wanted to see what the primaries were doing, and she wanted to see what the juniors were doing. (Molly) And I think, too– (Sue) We have the advantage we'd share a lot in the car going back and forth, but it still felt like "What are they doing next door?!" (Molly) "What am I missing now?!" Well, at least that's something I wanted to say...– I can't remember now. (Sue) Sorry to interrupt. (Molly) No, no. Something about the idea of time. Oh, I know! Even when we were at the different activities, I found that I didn't have time to get around to all of them, so I would have enjoyed being able to puddle away at them the next time we met. And I know that's a horrendous task for the people bringing in all the supplies but, at the same time, I really felt as if I needed more time. I think that happens in the classroom at lot, too.

(Sue) I think that some of them, rather than going every two weeks– because I think– that's what I found, that two weeks was a bit of a push, you know– maybe sometimes a session might be longer? (Int.) And then maybe only once a month? (Sue) And once a month? I don't know if that's a good idea because then I could just see getting so exhausted by the end of that, not wanting to go back. It's six of this and half a dozen of that.

(Int.) This is the kind of information we need, though. That's really helpful because we– you know, those kinds of things typically don't get said on evaluations.

(Molly) I think the sessions that went from 4:30 to 7:00 o'clock should have gone on later. I know it's difficult for people to schedule that, but those were the days when we had a great deal of activities to go through, usually, and those were the times that I felt that I needed more time to work with the materials. **[PT(A), p. 14-15]**

****

(Ann) Well, sometimes if there was– I think there was one sharing time when maybe you felt that some people were repeating themselves and that maybe we were wasting a bit of time that could have been used on something else, by repetition, but it WAS good to have a chance to discuss things. So, really, I couldn't think of much– (Hazel) For the days we worked in the morning until noon on activities and then we grabbed it as a group to share– that type of thing– I found that maybe that could have been cut shorter, and as we were saying the same things over again– **[PT(B), p. 20]**

(Betty) No, I think that's one of the things I DID like that maybe I– I mean, it was important enough– I find if you've had a whole day, and you're supposed to zip some place and go, go, go, go– I just find that's very hard on a person, and you're not as productive, and I think if our boards think it's important enough to do this sort of thing, then they should really give us the time to do it when we're fresh and our minds are working properly, and that sort of thing. I agree. I would think– **[PT(B), p. 20]**

(Jean) I'd like to have even longer things like Paul was bringing in, but maybe not so many of them– just one or two, to have a chance to play and do all the things that maybe the kids could do, instead of having maybe six or seven centres. You know, have one or two, and have time for questioning or "What would you do with this?" and what would you expect, you know– is there going to be any record-keeping here? What would you expect? Or is it all just fooling around and that's it? That's fine if that's what it is, but I'd like to have a little bit more time to do something like that.

(Int.) So you mean trying to explore the ins and outs of it, so that helps you anticipate how the kids would react to it?

(Jean) Umhmm. If I have a lot of time to play with it myself–

(Jan) And narrow it down to one area or something– such as magnets or something

(Jean) Maybe just doing– you know, going to the water and doing a couple of things there. Then going to the bubbles, and going to the balance, but maybe getting in depth in one or two of the areas. **[PT(B), p. 20]**

****

(Int.) **Let me ask you the other side of the question, then: what did you like LEAST about the project? I mean, that seems like a funny way to ask it; let me make it sound like a productive question, or a constructive one: what, about the project, could be most improved for next year?**

(Phil) ..., I would say that was something we didn't do enough of, was talk to each other and share some of the ideas, because we just did it on occasion. And I would also like to have the opportunity to go and visit more classrooms and see how you're doing the unit on bugs or a unit on airplanes so I can steal your ideas and go back and prove mine. And if you want to come and see mine, I'd be glad to let people come and look in my classroom. I think that's where a lot of the extension for learning for teachers really takes place. And I don't think we just had enough opportunity to do that. We did it, but I'd like to spend a LOT more time doing that. **[JT, p. 11]**

(Alice) One thing I found was the time that we came– like, you'd come at the end of the day when you were really tired? And I felt sometimes that I really didn't give it my best because it was a day I was particularly tired. You kind of sat back and you were absorbing it, but maybe not the same as you would if you had been fresher. Even if it would have been held in the first part of the afternoon or earlier, but–

(Int.) Yeah, somebody suggested that at least one, and maybe to start off with next year, full day session, and to try to get teachers at their best time because you're coming in battle fatigued. [**JT, p. 12**]

(Don) Time-frame. When we came out, most of us were tired; we'd had a busy day, and trying to get here, and we were often just a wee bit late, and had to leave. I had to leave– we have to do it at a better time so that we will gain– [**JT, p. 16**]

(b). <u>This Program Compared with Other In-service Experiences</u>

(Int.) **How would you compare the approaches used by those two with the approaches used by other people in elementary workshops you've gone to?" Or elementary science courses. Are they pretty much the same?**

(Molly) Well, I hate to tell you but I've never been to any others. (Int.) All right. So, no basis for comparison. (Molly) But the other thing that I notice in Ministry documents is that most of what I see there is not meat, it's just semantics. And what I see there, and what I've tried to put into practice in my own classroom isn't the same thing at all. I want more than air; I want practical suggestions, and I would hope that that's the type of thing we would have in an in-service in science.

(Int.) And that's what you found, I take it, to be the case here.

(Molly) Yes.

(Int.) **How would you compare it with workshops in other fields, then? Not just in science.**

(Molly) Any Math workshops I've been to have been similar to the science. The Language– any of the Language workshops and courses I've attended have been very different. Many of those have been "theory-first", and then "here's an idea– this is how you implement it– bang, bang, bang! But you don't get a chance to try it yourself. (Int.) No hands-on for you. (Molly) That's right, until you go into the classroom and try it with your own kids. [**PT(A), p. 35**]

****

(Int.) A couple of other areas to cover: **how do you think the approaches that were used during the course of the year by Doug and Brian– how would you compare those with other approaches you've had in other sorts of workshops? Are they similar or different and, if so, in what ways? What do you see as unique about the kind of experience you had?**

(Debbie) Well, again, it's a hands-on, isn't it? I mean, you just don't get many opportunities– at least, I haven't had. You might describe it, but you don't have things right there to do it. (Jan) Also, the giving out of equipment– the things that we've received in the course that we actually have at the start to begin working with.

(Nancy) The people input. The people within the group, and also the people who came. (Penny) It really 'opens' you, having other people share, you know. Just a little bit coming from them– they would take an idea from one of us and use that and just go with it. And there's always lots of what you need for that, I think. It was good. **[PT(B), p. 41]**

3. Impact of the Project: What Did You Learn From Or Get Out of the this Program of In-service?

(a). On Ideas About Children as Learners

(Int.) **What have each– have you learned anything about your kids as learners, and try and use that too. Have you seen them respond differently than they would have to the other kinds of things you've done with them before that are not so hands-on.**

(Molly) Well, the most obvious thing is they're not passive, they're very active. (Int.) Yeah. (Molly) And you can also– I think– when you look around the classroom, you can see who your auditory learners are. You can see who the kids are who have to have the manipulation in combination with the verbalization, you know? And then you can see the kids who look at without even touching it– "I know what that does– blah blah blah blah!" No, that is my "in-house" teacher; that is the child who helps the one with the problem. (Sue) Quite often– yeah. (Molly) They love that (inaudible), too. **[PT(A), p. 13]**

(Int.) Did you get a chance to read the article by David Hawkins called, "Messing About in Science"? We handed it out prior to their arrival. But he talks about when they first started out with some of the activities, and one of his examples is pendulum, because he did a lot of the work on that for the Elementary Science Study. But, you know, the same kind of problem you're running across; he thought, "Well, we'll do this in a short time. We'll let the kids work on this." And this is two weeks LATER we're still talking! And he said, "Well, we've learned! Who would have ever thought of an underwater pendulum!" Kids would, but scientists wouldn't, or people! (Sue) What a great idea! Underwater? I didn't see that one! (Int.) But, all kinds of different possibilities. Paul talked about that, too. I don't know if you were– one of the sessions was his. He says he never likes to write stuff down until he's done it with the kids about four or five times, and then he has a feel of the various directions they're going to take it.

(Sue) Yes, I like being comfortable with the kids being able to do MY thing that I've assigned to them, and let them "Hey, what's going to happen next?". You usually don't want to have to ask– THEY'RE going to ask– they want to do it. And say, "What would happen if you did this?" Also, some of the things that I wouldn't have done before was allowing them to predict– you know, rolling balls down the street– "What do you think is going to happen?" Of course, a lot of the kids play pool and I didn't realize that. "I was really, really, really surprised! They knew what was going to happen better than I knew when I rolled these balls together on the same track. And it didn't occur to me until I got home and told my husband about this

exciting thing we were doing, and he said, "They play at this on the pool table down in the basement!". "Right!" (Int.) That's a nice connection. (Molly) And a lot of the sports that the boys in particular are involved in are based on scientific principles, if you look at them, you know, hockey– there's speed, there's direction, there's velocity and there's forces, and so on. (Int.) Well, the things we we routinely do. You hate to genderize it, but suppose you're working the the kitchen and a cup starts to fall. Sometimes you can rescue it, but you KNOW where it's going to go. So, something in your experience has helped you to say, "Hah, this is like something that happened before, and whenever that happens this will be the result". You call that a 'scientific theory', so that what YOU'RE saying– another way of putting it would be (I just want to see how you react to this) is the kids already have theories when they come to school. (Molly) Yes, they do.

(Sue) Yeah, but I think that the teacher's role is to bring that up to a thinking level a vocalization level and then take it further from there.

(Int.) Gee, I've always marvelled– and it's usually the girls who are the best at this– how can they jump rope or skip!? .... You know, there's so much timing and judgment and getting everything to work together right, and knowing what's going to happen, that here, again, is a significant achievement that kids make, you know, kind of outside the classroom. Like the things they get in sports. But our science classes never seem to build on that! But you're saying, "Look, maybe we can do things".

(Molly) Even their marbles games in the spring are based on those same types of things. They know what size marble they need to knock another one out, and just how much force to give it. And, when you think about games such as golf, for example, you know that you have to hit something at a certain angle; you know that it's not always going to go where you think it's going to go, according to the wind or whatever. And I think that a lot of that is experiential background– the same idea with eggs– the kids have to learn how to break them properly. You know, that's not something that they learn at first when they try it. So if you're doing cooking with the kids in the classroom, and the kids haven't experienced breaking an egg at home, that's something they have to learn. And it takes many practices. (Int.) For them to get it right. (Molly) Yeah. (Sue) Some eggshells may be muffins before– (Molly) That's right.

(Int.) The cost of being a teacher! Eating 'gritty' muffins! **[PT(A), pp. 15- 17]**

****

(Int.) **Well, when you ran these activities did you learn anything surprising about the students? Did you find out things about them you hadn't expected, when presented with this kind of thing?** Let me give you an illustration: I remember Frank was talking about a problem he'd come across, Penny, at your school, and he said that "As long as we were doing sort official textbook science, where I would make a presentation or do a demonstration and the kids would take notes and I'd test them on it, some kids in the class were shining. (Many voices in agreement) The minute we brought the hands-on stuff in, the pecking order changed, and a whole bunch of them came out of the woodwork and turned out to be very, very good. And the

kids who had done well on tests– their standing began to fall. And it was a real dilemma for him.

(Ann) It's back to my point again about the tenacious child who likes to touch, to poke, to try– "Well, that didn't work; what happens next?" And that child doesn't– you know, tries it once and, if it doesn't work the way they thought it would, walks away. Doesn't, you know, try again.

(Betty) I think part of it that it really separates the regurgitators from the thinkers, and the children that often shine on the pencil & paper things ARE the regurgitators. They have good retention; they can regurgitate, and I think there's a real danger that they often– because I know it's happened over the years– that we label those children 'good students', and the ones that DON'T regurgitate are 'poor students'. And often it's the other way around. I mean–

(Jan) And it's not as though those children are necessarily bad thinkers. They've been through the hands-on activities; they can be exposed to ways of examining that problem which will improve their problem-solving thinking approach.

(Betty) Yeah. I'm saying that I know we often label children 'good students' because they do well at their tests, because they can remember/regurgitate. (R) That's right. (Betty) Where the children that maybe have difficulty in that area and learn more by the tactile– touchy/feely stuff.

(Jan) And if they had more tactile they'd learn even more faster. (R) That's right.

(Nancy) Well, I've had a <u>really</u> interesting experience this year, because I've a little fellow who came to me from Toronto, and he's 3rd grade. And he's been in a private boys' school that was totally a Montessori school, and he started when he was three. And he is one of the brightest kids I've ever taught in my life. And when we tested him for the gifted program he went off the scale– I mean, he's just OUT THERE somewhere, and he is very, <u>very</u> bright. And you can tell that from the way that he talks and he reads and he writes. And he has all these wonderful, creative ideas. He's just a very bright child. Well, the more hands-on mucking about, making things, we did, the more he backed up. And he could hardly cut. And we were making those– remember those flying things that we made? Helicopters, or whatever? He couldn't do it! He couldn't cut the two straight lines and fold it this way and this way. He had NEVER done any of those things. And I discovered this very early in the fall, and it's very interesting because he's had to be part of it, obviously, if these things are going on and everybody else is doing it, but he had NOT had experiences with those things. And yet this is a very, very bright child. But it's just the other way. And he's had to work really hard to do those things, those hands-on things.

(Jan) There was a student in our school– this was in Quebec, and it was a 7-11 school. And the child came in in Grade 7 and could not handle a regular system, and yet that kid tested 'genius' on–

(Nancy) When he got his first report card, his parents both came in because they wanted to know where the Canadian Standard Test Scores– at what grade level and what point he was at– and they were non-existent on the report

card, you know. But, you have trouble with the report cards the way they are now– Jan – it's fascinating. Where was his reading test score, and what grade level was it? I mean, this was what they had been programmed for, and what they looked for, and here I am saying when it comes to a task that he has to follow directions for, and carry through, then he's having some difficulty! What does that mean, you know!? It's very interesting, because it's just the exact opposite of what we're attempting to do, and he doesn't have those experiences. Fascinating! **[PT(B), p. 35-36]**

****

(Alice) I take it the students, too, once you get them away from the textbook idea, just get them doing something very simple, that's when you really turn them onto science, and they want to stay with it a long time. And we found that this year when we did the Science Olympics at our school; like, the kids, they just wanted to go on and, for every idea, they had three or four more to follow it up. We could have done that half the year.

(Phil) It's amazing how much I think we've really stymied children in the past with what we thought was good science, because some of the activities that we've tried, they've branched out and gone in fourteen different directions. We started with one idea and they just went like this– and at first I scrambled to keep up, but then I said, "What the heck– they'll go find the answers anyways!" And they would come back and report, and–

(Alice) I know, the first year, I was really afraid when the kids started making the paper airplanes. I always thought before they were going to make them and throw them at me. But, when I told them it was all right to make them, and when they wanted to try them that we'd go into the hall or something or on the stairs, they were making them, and they found books in the library on how to make them better, and they were competing on their own. And we're still collecting them, and they'll have a race before the end of the year, but– it just made me think about it differently. **[JT, pp. 9-10]**

(Alice) And I think there's a lot more thinking going on when they're sharing in their books with each other and learning from each other because you then not only have one teacher but they ALL become teachers. And as they find something out they share it, and so you've got a lot more people sharing and a lot more people learning and a lot more people thinking. **[JT, p. 23]**

(Int.) .... Frank was telling me something that I think brings that out a different way, and I wanted to see if you had that experience. Those are my two stories: now, my question. The session just after Christmas, I think, Frank, you came up one night and said, "I've got a dilemma in my classroom", and it was a good thing, you told me, that you had an understanding principal. One of the things you said that's haunted me ever since was that some of your students who had done well on the pencil and paper science had, when you moved into the hands-on science, lost their standing in the class, in a sense. And the kids who had not done so well on the pencil and paper science began to take off with the hands-on science. So you got kind of an inversion–

(Frank) Yes.

(Int.) – in the evaluation or the standing of the kids in your class. Have other people run into that?

(Phil) Absolutely. I have two boys with learning disabilities in my room– If you want to see hyper, you should see these two guys. And the hands-on science is one place where they have been allowed to shine and to compete with the best students in my class. They discover things and see things that even my two kids in the gifted program don't see!

(Frank) That's what happened to me. Like, I know of one instance– one of the children who is in the gifted program was visibly upset– he got skunked, and he was doing much better!

(Don) I had a similar situation where the winner of my Science Olympics was a special needs student. He beat out all the others.

(Frank) I guess, you know, that's sort of an outside issue, but it sort of makes you wonder how we measure intelligence. [**JT, p. 24**]

(Phil) I've thought that, with this bug unit, I wouldn't have any girls who actually LIKED creepy-crawlies. I can't believe– the girls actually brought in as many neat things as the boys, and that really overwhelmed me– I didn't think that would happen. I've got a couple of squeamish girls, but that's culturally induced I'm sure. But the rest of the girls went out and they brought in spiders and worms and diving beetles and pond beetles, etc. And that amazed me. Now, mind you, my kids are 9 and 10 years old– I don't know if they'd do that, the 14-yr. old girls in Grade 8, but the grade 4 and 5, I couldn't believe it.

(Sandy) That's one thing I found, too, is I started out with a science club with six or seven really keen kids who wanted to work experiments at lunchtime. It was mainly the girls who wanted to do it, and I thought, well, that was great and, if you can keep that up, then maybe there will be more girls, eventually, in science.

(Int.) Hmm. Did other people come across anything surprising about their kids when they got to do these things?

(Don) What I found was, there were these kids who just didn't think. They knew certain things, and suddenly you realized that, gee, you'd been underestimating their ability, their knowledge and what you'd provided for them was an opportunity for them to shine. And they do shine. By taking a different approach. [**JT, p. 38**]

(b). <u>On Personal and Professional Relationships</u>

With Teachers and Principals

(Int.) Well, that's one thing I wanted to ask you. **What sort of response have you had from the people in your school?**

(Sue) My principal's been very supportive. He likes this sort of thing, and when he was in my room– are these things connected? (Int.) Yes. I think they are. (Sue) He saw my first lesson. If I'd known he was coming in I wouldn't have done it because I was too shy and I wasn't too sure what the (inaudible) was going to look like. And that was a sampling. And he did– he was really pleased, and the kids were really good. **[PT(A), p. 26]**

Other Teachers

(Int.) ... we've talked about principal's reaction. **Do you have any sense of how the other teachers in your school felt about what you were doing this year?**

(Sue) Actually, I don't think that would happen in our staff. (Molly) No. We have a very diverse staff, a very large staff, and I think, if anything, most people would say, "Hey! What have you got that you can pass along to me?" Like, the teacher that I work with most often is keen to come next year, so– and just from what I've learned this year. **[PT(A), p. 30]**

****

(Marnie) The fact that this is both boards, too, is really good, I think, but I think there should be more of this kind of– (R) Me, too! (R) Very much so!

(Int.) What do you like about that?

(Jan) I think it's the whole idea that everyone's in and sharing the same activities and ideas– not that it seems to be so much in one camp and another camp. I think if we worked together there would be a lot more–

(R) It doubles your resources, really.

(R) Yeah, you've a whole new group of resource people that you didn't have access to before. **[PT(B), p. 10]**

(Int.) ... **what sort of feeling did you get from other teachers, and from your principal, about your involvement in this project?**

(Penny) I guess that's a really good question because I've noticed that recently– we were doing some work with the tube, and there was, like, a lot of chaos going on– there's generally a lot of chaos going on anyway, but this day it was particularly loud. And the teacher who teaches across the hall from me I don't think has had much science experience at all, or anything like that. And at recess time she came over, she was so interested in finding out, and said – you know, "Would you sit down with me and spend an hour or so telling me what kind of science stuff you're doing?" "And I thought that was really good because she's not that open, usually, and for her to come over and say that." I know she's not confident in science at all, so that way she's given me an opportunity to share. I think that's a real bonus. A lot of people ARE open, and will be open if you say, "Well, I'd like to share something with you," but I wouldn't feel comfortable doing that with her if she hadn't come over and said– you know. So, in that way I can see it

growing. There's something spreading there and it's really exciting. [PT(B), p. 35]

(Betty) What I find, too, is that my kids are talking about what they're doing in the yard, and other kids are going to their teacher, "How come we're not doing that?" (R) Yeah!

(Penny) Or if another class comes into the classroom and they see the stuff around– like, I have that tube sitting in the corner, and a grade 6 class comes in for math, and just as I was coming in after my planning period, I saw them playing around with it– "Oh, isn't this cute! How does it work?" It was really exciting. I think that's so important that they're talking to each other about it, and to their families. I had some parents come in and say, "You know, that was really neat. Janice was so excited about (we did one activity with that step-through piece of paper– cutting it)– and he had all of us do it at home that night!" So that spreads to older kids. [PT(B), p. 35]

With Parents

(Int.) **.... have you had any feedback from your parents– any of them– in any way, shape or form about–**

(Molly) Yes, I have. I had comments from parents– "My child tries at home everything you do at school". And they're amazed. First of all, I think the child actually knows what he's doing, how to go about it, how to organize himself and produce results that make sense to the parents because the child can explain what's going on. I've had maybe three or four parents make comments like that– "My son did ..."– "My child was so excited when he did such-and such". I don't think they're all aware of what's going on, but some of them certainly are. [PT(A), p. 38]

****

(Alice) ... I'm in ... an area where the parents are really on top of things and know a LOT about education and how your classes should run. And they come, and they tell me, "I really like the kinds of things you're doing. My kids are really interested this year". You do get feedback.

(Don) I think that's where we're winning– through the kids, when they go home.

(Alice) Yeah, they go home and they're really turned on–

(Don) You get notes coming into school: "Gee, I liked what Johnny was doing today! He seemed to be so excited!"

(Alice) – And they want the kids in your room! [JT, pp. 25-26]

(c). <u>On Approaches to Teaching and Learning</u>

(Molly) It's so practical. I have not done nearly as much, I don't think, as Sue has, and– but yet the few things that we HAVE done the kids just love. And they

keep saying, day after day, "Are we going to do Science today? Are we going to do Science today?" [PT(A), p. 4]

(Molly) The one thing that I don't feel that I'm capable of doing yet is designing my own activities. Like, coming up with things to put together the work to show certain scientific principles. [PT(A), p. 31]

(Int.) **Final thing. You said, when we were talking outside the school the last session that you thought maybe the most important thing you got from the in-service this year was not so much strategies and techniques but some kind of philosophy.**

(Sue) .... Applying that way of looking at things when I'm trying to do something that's not definitely science, I'll say, "How can I get something into this that's going to get that questioning process to go that catapults them– putting things together– these mechanical machines together– to make them work?" When I first started that, the first couple of kids just made the model according to what the picture looked like. It didn't work. They couldn't figure it out but they got so sophisticated after a while– it was incredible, the difference– and I'm trying to look at each of them– any kind of units– how can I get some hands-on requiring process going in, whether it's Geometry or it's Medieval Unit– what else do they do?– oh, Painting. I've got a lot of colour– and mixing colours in my art– because I wasn't having time to do all these wonderful things. So I combined them and made this– this is an art lesson– the kids have got so that they really look forward to Day Six "When are we're going to have an art lesson?". Quite often it is whatever we're doing, but it's still that big day they know that they're going to have art and they really look forward to it. And this– applying the science to that– the mixing of colours, using the water drops ??? – it's really quite a lot of fun. And then going in for mixing the paint just to see what they could do with colours. ??? We did it for two days– two separate weeks because, first of all, they got the primary and secondary colours and we thought we could mix them just– and the next time we didn't know quite what we were doing with the water droppers but that was ??? I don't know. Maybe something AGAIN with the water droppers and mixing colours and went into tints. And the children did these pictures that– they had one shape and they'd colour it with one colour– pigment– and then they'd tint– just add a bit of wet paint, and painted an outline, and then a little more white paint so that it went lighter as it went to the edge of the paper. Just that "exploring" what they could do with the colours. It was– I never look would at an art lesson like that before. I would tell them if you wanted them to get the colours out of it. [PT(A), pp.39-40]

****

(Int.) **How many of you actually tried out those kinds of activities and, if you did try them out, what was surprising what happened when you did?**

(Betty) Well, I'm working on many themes right now, trying out your ideas– trying to get some of those things together– like, I like that dress-up idea that you had for guests of the insect. You know, I'm just not prepared to do

that yet, but I'm collecting scraps and scratching around to collecting things....

(Jean) I did the mirrors that Paul had brought for us– not as a whole class activity. It was just at the back, and I would give, you know, pairs of kids the morning off, kind of, to go back and do that. And I got a lot of enthusiasm, and they still go back and do the stuff– the stillbox there. And right now I'm doing my own volume unit, but I'm trying to incorporate ideas from Paul; water pouring and that sort of thing. (Int.) Okay. (Jean) That's one thing I liked, because there wasn't any pressure– like, they'd say who tried out– they weren't saying, "Jean, why didn't you try it out? the next day?" you know? And I liked that. You know, in the summer, when I'm planning for next year, I'll be able to incorporate much more of this with them. But when you've kind of made a lesson plan for the year you're supposed to follow it, I guess.

(Jan) I feel that next year– going into next year– will be a lot better with having had this in-service up to now. Like, a lot of the things I've been doing this year have just sort of been trying it out and there's been no pattern to it. But I feel that to start out in September I have a better handle on it, and it'll be better starting at the time.

(Int.) So what I hear you saying is you can't just come to the workshop or come to an evening session, turn around, and three days later be running that thing smoothly in your classroom. [Many Voices] No! (Int.) There's a lot more involved.

(Jan) There's a lot more. I've been trying to do pendulums and I start– which I've never ever done– and I start with them and then find out all kinds of things– that I wasn't using the right thing, that I needed something heavier. I was just trying to use something I had in the classroom. And then I didn't have them swinging from certain things. And it should have a longer string on it, and so on. So just even– you can get started but you don't really get into it until you experiment yourself. And I have very little science background so it means a lot of trial and error for me as well, as a teacher, and finding out and realizing when the kids can't see any difference in it there must be something more wrong with this, so–

(Int.) All right.

(Betty) But I find even with a science background you can't– I can't present anything to the kids unless I've been fooling around with it first. You know, I don't think anybody can just go in cold and say, "Here!" and feel comfortable with that.

(Jan) I think it's almost becoming a family affair because you end up taking it home and trying to– you get your husband and your kids and we're all– (Betty) That's right– you find out if you have children of your own. They're your guinea pigs.

(Ann) I tried the mirrors and pendulums and just– and balance– and a number of the activities to sort of stuff them in to see what kind of reaction the children would have, but I was pleased when– we're working right now on

"pond studies"– I have a pond– and I realized that I could do some surface tension activities. I didn't really– you know, you're always wanting to integrate. It seems, by nature, we want to integrate things into something. And I realized I could do those activities with the idea of the water surface tension and the water strider and that kind of thing. We were talking today about the insects that go along the surface of the water. So I thought that would be fun.

(Jan) I think that probably this in-service has given us an awareness of how to integrate science more. (R) Yeah.

(Int.) Well, I remember, Debbie, you were talking– I think it was a 'make and take' session– that you hadn't used it so much in science, but there was a unit on lumbering you were doing, I think it was–

(Debbie) Yes. And we did a bit of work on the balance, using some of the different materials that they brought in. I found that children brought a lot of pieces from different kinds of wood, and acorns, and different things like that. And so we tried a bit of balance using some of the materials.

(Int.) Well, is that a different way of approaching that unit– a unit like that– that you've used before?

(Debbie) It would be for me, seeing all the extra potential. Like, I try to work in themes and do these things that I saw a lot. And, see, every time now, I find that when I do take a unit I'm finding so many– in fact it's hard to finish a unit now because they keep wanting to go off into all these other areas, and keep going. So I find out that when I do a unit, maybe I won't do as much as I used to in one particular area, and then rather I will do more different types of activities. And so that's how I've changed a little bit. But I agree that I sort of have to sit back and plan things ahead in a unit like this, and I'm not as likely to just slip something in unless I've had a bit of planning time to see how it's all going to work together. And I think my potential was more for seeing how long these things are going to go next year. Because that's how I seem to operate.

(Int.) An important part is kind of an environmental impact study. Is it– what sort of consequences will it have if I do this, and how will the kids react to it? What other things that I need to take account of– will ceiling tiles come down? and, you know, will this darn thing work in the first place? It looks like a lot testing that you need to do to be confident and feel comfortable with actually doing that. But then I remember early discussions we had, when you Doug and Brian kept saying "Extensions, extensions!" You maybe recall that, too. And people weren't saying much. Now I hear people saying quite a bit more. So perhaps it does take time to get the feeling for using much more hands-on. Would that be the correct way to describe it– ?

(Debbie) Oh, I think that's very true. I think the children must pick up something from you too, because I find that towards the– in the last term, now, they had been bringing in a lot of things and, you know, we get going into so many different areas because there I was bringing in things they wanted to try out or plant or show or look at under the magnifying glass. Because once you get started it– they really pick up. And I think that that's

something I've really noticed. I guess I've changed in that way because it wasn't happening at the beginning of the year.

(Marnie) I think kids must sense that very quickly because we've had a lot of tadpoles and newts and things like that coming into the school this spring and, in a couple of instances, the classroom teacher didn't even know that it was in the school. But Doug had been sought right away, and then they came looking for me, to show it to me. And the classroom teacher hadn't even been aware it was there.

(Int.) So the word gets out that you people are interested in these sorts of things?

(Marnie) Well, they're very selective in who they choose to share it with because they know that there's going to be a response. **[PT(B), pp. 27-31]**

(Int.) **Marnie, you started to talk about that. How, when you tried these things out– I mean I sense there's a lot of variety in how you– how did your kids react to it?**

(Marnie) They're always really thrilled to do anything hands-on and get involved and that type of thing.

(Int.) So, is it just the novelty of coming in with the new activity. (Marnie) I don't know. I think it has to do with natural curiosity about their environment. **[PT(B), p. 31]**

(Marnie) It goes along with our descriptions of Paul. I mean, his enthusiasm just overflows and it's contagious. And that's the kind of thing– I mean, I feel that science is a fantastic starting point, but that enthusiasm then carries over into other kinds of learning.

(Int.) So the kids become enthusiastic.

(Jan) Right. And the discussions that go on! Like, a lot of times, away it goes. You might start one small group but then later on, and that small group then really teaches the next group how and what to do with the materials. And if you listen, you overhear some fantastic discussions about why things are happening and what's happening, and very– actually full of knowledge– showing their knowledge of the world. It's fantastic. **[PT(B), p. 31]**

(Int.) Okay, so when you try out these activities with the kids, you find them to respond very positively and quite enthusiastically to them–

(Jean) But I don't think– like, Penny said not every child is going to respond to EVERY– like, not everyone was interested in the mirrors. A lot of kids were, but you can't expect everyone to be triggered off by that, but maybe the next thing you expose them to– that one they'll be keen about. **[PT(B), p. 32]**

****

(Connie) I think if you get into these activities– I know when I got into Colour I wanted to try to sum it up with the kids, and we talked about what did we do, what did we observe, and whatnot. And we talked about it on the board. And I did some notes on the board. And I said, "Now, if you want to do your own, you go right ahead." And I would say at least half of my class said, "I want to do my own", and they wrote out their own– what equipment did we use, what did we do, what did we see, but at least we ended the unit with a little conclusion or whatnot, and they included some of their filters and some of their observation sheets and whatnot, so there WAS something in a notebook that said, "Now this is what we did". But I was PLEASED that the kids would say, "Well, can we do our own? Do we HAVE to copy?" Different kids– some kids– WANTED to copy what was on the board, but I think these kinds of activities, because the kids do get so much out of it, that we might get more to them wanting to do their own note of writing down, "What did we do?" and "What did I find?"

(Tanis) But I'm saying– make sure that they do SEE some of these terms and understand them.

(Alice) I think one of the reasons that teachers worry so much about 'do the children have notes?' is that they know they're going to be testing them. And so many times in the past we've evaluated them through written questions, and we should now, you know, be doing more observing and picking up notes from day to day, and watching the way they interact, and that's all in the new document, *Science is Happening Here*– it's talking about these forms of evaluation. We're just not– because it's new to us– we don't think we're really evaluating them, but we are.

(Connie) But, I think– don't you think sometimes, with some kids doing certain things like that, they might say, "Well, what DID I learn? Like, it was fun..." and I think you almost have to say to them, well– and TALK about it!– "Oh, yeah, we did! It wasn't just fun, but we did!" And I think with some kids you have to honestly point that out to them and say, "There WERE some things that were very specific. **[JT, p. 21-22]**

(Alice) Concepts, yes. But they've learned that they can enjoy science (inaudible)

(Connie) Oh, I'm not saying that. I'm just saying that, at the same time I do think, with some kids anyway, you have to– whether you make a point or whether (You DID learn, It wasn't just all fun.) –but there was some definite learning that went on.

(Phil) I'm feeling terribly guilty. We didn't do a lot of note-taking. We sure did a lot of talking, and individual children had their own– I don't know what you would call it?– "rough sheet" where they made their own notes and pinned it up and we talked about it when it was all done. And we made– I did a lot of the frameworking and thinking skills that John Ross has in science, and tried that in there. We did other things than write paragraphs and fill in the blanks because I really feel that, well, as you grow older and go to university, they don't write in paragraph form, and you take charts, you take point form notes, and you get the major concepts down, and then there are many other opportunities for the children to learn paragraphing, etc., and so I– I think I had one notebook with six pages in it and the rest was all on chart paper or, etc. **[JT, p. 21-22]**

(Jack) It takes a lot more structure than standing up there, teaching the kids a lesson!

(Alice) Yeah, that's what it DOES take, is structure. And you have to (more than one voice)–

(Phil) Oh, yeah, you've got to be 'overplanned' with control– the child-centered approach– because otherwise you've got absolute chaos. It may look like chaos anyways, but at LEAST you can answer some of the questions... [JT, p. 25]

(Phil) Well, the oral language certainly picks up in the classroom when you try some of the activities that have been presented. A lot of talking, a lot of discussion. I find that– and I tried the colour ones where you mix up all the colours on the overhead and you use the food colouring and dish detergent and milk and a couple of those stations set up all at once. And the children talk a lot; they learn a lot from each other, and I found that, even though it's noisy, the two children that I've mentioned before that WERE hyper, and I don't usually get a heck of a lot out of them, actually assumed leadership roles and were very observant. I could not BELIEVE the things that these children could see and, as Frank mentioned, both of my children who do better in the gifted program were quite put out because they were no longer THE ONES that the children were looking to for the answers that they could come up with. It was the other two boys who would normally drive you a little insane. So it really gave other children an opportunity. And, the gifted children– it's not that they're suffering– they're still doing it all right– but the other children learned some respect for the two boys that were usually the ones who were always in trouble, so I thought that from that point of view it's been great. It's just a balance in the class. Everybody has something to offer.

(Int.) How about other people's experiences?

(Alice) One thing that I'm doing now from what I've learned in the past is that I'm doing my science in chunks of time, like half a day of science, and about two weeks ago I had an Environmental day, and in the morning we did the first hour and a half all about acid rain– experiments with acids and bases, and have them understand acid breathing and what it does to the environment. And from there, after recess, I took the Project Wild book, and a lot of the environmental type games relating to the instincts for survival, and then ten minutes of living things– all of those kinds of concepts– and, at the end of the morning they said, "Gee, this is really great! When can we play again?" They just loved it! Like, they just felt it was a play day! And yet it was all science, and at the end of an activity we talked a little bit about it, but we didn't drag it out– we just kept moving from one thing to the next. And I felt that they got an awful lot out of that and yet we hadn't written anything down. A lot of doing things.

(Int.) What other– people who actually tried these things– what other responses did you get from the youngsters?

(Frank) I found that there were a variety of responses with the balancing activity. They sort of came to a dead end, a lot of them– they didn't really know how to extend them. Like, these belts here– if they were able to play, they could

have played around all day, probably. The kids found a little bit of difficulty with that. Some of the other activities– one that we did with light– just one aspect of what we did here, and what I learned this past summer in a summer workshop with the mirrors– I may have mentioned this before– putting a mirror on the blackboard and using a film strip projector for a light source. And having them predict where the image would– putting it at an angle and having them predict where the reflection would be on the ceiling. And carrying on from there. Putting a mirror there, and having them predict where the image would form– you know, it even felt so neat. That activity went particularly well. Doing one on 'flight', using the science– sciences– starting off with the paper helicopter– they really went after that in great style. Like, you never saw so many variations on the rotors that they made on the paper–cutting zig-zags and looking at them. But, as I say, not all the activities were really as well received as I would have expected or hoped for.

(Seth) The mirrors were a real benefit– getting those and light box activity– the box the paper comes in? Stacks of paper for the photocopier? (inaudible) Gave them about seven mirrors. When I first tried it out we had them cooperating because if you tipped it up, of course, you'd lose it at the bottom. And, by the end of it, they could do it in three (inaudible)– and the way they concentrated (inaudible).

(Connie) I think the enthusiasm that they showed for them, eh? They get gung-ho into it and they want to come back and do things again, or they'll tell you about having done it at home and whatnot. I think that's the encouragement to go on and to do some other things. I've gotten away from it because I've got to get into some other things, but I'm hoping, before the end of the year, to get back at one of the others. I did the colour. I think they'd have done that for the rest of the year if I'd let them! And when they have free time they'll often still come back to me and say, "Can we do the food colouring with the filters?", or particularly in the ice cube trays, or that kind of thing. So there's a definite interest that stays with them and a fascination for some of these, that you know you've really got them excited about something.

(Int.) And you haven't had that feeling with other kinds of approaches to similar things?

(Connie) Well, yes, because I did– now there was definitely hands-on, the plants things that we did– there was a lot of interest about that, too. There was a lot of notes; we DID do a lot of notes, and we talked about different animals and whatnot, and when we went down to the Science Center we had a lab there and went through the animals again. There was a lot of it– like, I think it's a time when the kids are very interested in the world around them and, you know– but, again, there was quite a bit of hands-on, but certainly not as much as in some of these activities that we've done. [JT, p. 33]

(Alice) I think what I found– we were doing those– was that if you had a background upon, let's say, was gravity, or whatever concept you'd already learned, then you tried– I was trying too hard to relate what I knew to what was happening. I felt that that was not a good approach. Then it didn't

mesh– the answers weren't coming. But, once I got away from that, it was better. The kids were enjoying it more.

(Int.) Say more about that! So, you were trying to mesh it with what?

(Alice) Like, for example, the tube with the different layers of sediment in it. All I could think of was all the times that I had had kids do experiments– showing the earth– like in some soil, that you would have the heavy particles at the bottom and the less heavy ones next, and so on. And then it settles. And so I thought, "Well, that's what going to happen." And the one time I picked it up and shook it, that was the only time it didn't go back together in that order. But at first I thought, "Gee, I know how this is going to work. It's all going to go like that." And it didn't happen like that, and I thought– (inaudible) And we got Frances working with it. And she said, "This never happened before!" So it had something to do with the way the bubble or the water– I don't know how, but we didn't have an answer any more! But I was always looking for something to happen the way I had learned it, because I was taught science that way, that there's a whole lot of things and you memorize them. You had all these concepts in your head, but you couldn't explain all this.

(Int.) Yeah, and you're not a good observer, right, because if–

(Alice) Yeah, because I never was given much chance to observe. It was always like that– a regurgitation of what you learned.

(Phil) Our science was always controlled. The experiments we did in high school and university were set to work out a certain way, and we knew how they were supposed to work out. So, in a lab in university, you worked towards the answer because you knew that's what was expected. You didn't experiment– you just made sure the experiment came out the way the prof wanted it.

(Alice) And I can remember teaching Grade 7, 8, 9 and 10 science 27 years ago, and I'd go in on a Saturday, set up my experiment, and I would make sure– and sometimes I knew just exactly how to cheat– that it would work. And I did that very well. I got really good at it.

(Int.) Yeah, we have the idea of Skinner's constant, right? It's whatever you multiply the answer YOU get BY to get the correct answer, right? [Laughter]

(Alice) And you never know (inaudible) the same application. It's like, today, that's where we're going, and if you don't know how it is, how do you apply it? And that's where we need to go. It's more like how does it fit into the real world? Like, we stopped short of the most important part. Maybe that's where we've improved a bit. **[JT, pp. 38-39]**

(Phil) I don't think we have to inject new ideas– I'm sure all of the ideas and all the curriculum is written some place. All we have to do is go and pull it and decide what we want to use, and try it out in our classroom and come back and report to the group that "We have tried it, and this is what I've done with it, and it works quite nicely." There has to be enough science

written in North America to keep us busy for the next hundred years (inaudible) a unit.

(Alice) That won't make you a better science teacher, looking through– I have so much resources that, one room, I dedicate my room to boxes and I don't even know what's in them. After twenty–seven years you've collected– and that doesn't make you a better teacher.

(Otto) Where does the child's interest come into it, too? You know? Like, a lot of these are topics that Paul or somebody has presented to us, and we needed them obviously, but the child's interest gets overlooked and, very often when you do your yearly plan or whatever in September, you know, there's no room for the child's interest when you, by the end of September, submit your yearly plan to the principal.

(Alice) That's why it shouldn't be done like that, and–

(Otto) And my insight into individualization is that it's trying to capitalize on each child's strengths and teach to the weakness, and work on interests too. So the child's that learning disabled...you know, what are strengths? And you try to individualize by capitalizing on those strengths.

(Int.) But, by the end of September, it's very difficult for you to have that information about your youngsters, isn't it?

(Alice) Usually, you know, if you open them up or give them the opportunities, you'll motivate them and the interest will come. And if it dies down you'll move on. You don't wear it out. But you have to expose them. [**JT, pp. 49-50**]

(Int.) **We seem to have talked about some advantages of using these sorts of activities. What are the disadvantages? What kind of problems does it create as you look at your situation– and, again, there may be differences among situations.** [**JT, p. 33**]

(Terry) Well, I think again, it depends– it deals with your personal outlook on things. I tend to favour considerable structure so we find out– as Alice was saying earlier– the space restraints. That's something we have to live with, and what Alice was saying a few moments ago probably is one of the best solutions to the problem. Okay, work with a number of centres, but then take a half day or whatever it is, turn your room into a science room, which I didn't, and once you find out– and I found this is other activities as well, especially– and, of course, I'm working with Grade 3's, but I found it even up in the junior grades, but if you have one centre set up or two centres set up, and you send four kids to this centre and four kids to that centre, those eight children are very enthusiastic and they're working, but the other twenty– one in their seats– they're doing little or nothing. And it even spoils it for them because the ones that are there, if it's some discovery thing they're making, or something– of course, first ones that do it– "Oh, this is the way you do it!"– it spoils it for the rest of the children who come. But I think maybe this is something that– in these groups, and we can talk, and I picked up some excellent ideas just today on how to get around that,

or the possibilities of getting around it. I'm in a portable, too– there's more of us I suppose that are– and you can have real problems with water–

(Int.) You don't have running water either? (Terry) No. [**JT, p. 33**]

4. Teachers' Views of the Aims of The Project

(a). On Comfort Level

(Int.) .... **The whole rationale that lies behind the thrust of in-service and a lot of the other things that are happening in elementary science really centers around trying to raise teachers' comfort level. Is that one of the things that you think had to be raised for you as a teacher?**

(Sue) Definitely! In science a lot of what we do looks like play. It would be hard to justify. And having somebody give me permission– I think I said before, give me permission to do this– I know this document over here says "hands-on" stuff and this document here says "hands-on", but you see we need something to say, "GO AHEAD! DO IT!!" (Int.) Why IS that? [**PT(A),p. 35**]

****

(Betty) Yeah, I think that's one of the things– I felt SO isolated because I do have some science background, I didn't see a lot of it happening, and I'm saying, "I'm doing this; nobody else seems to be doing it– maybe I'm doing the wrong thing!" Nobody seemed to say one way or the other what you were doing was right or wrong, or whatever, so you go sort of fishing in the dark and when you get together with a group of people you find out, well, hey, things aren't bad at all– your ideas weren't so bad– this idea wasn't so good, throw it out– try this idea– you know– it's good to get the kind of positive feedback that you wouldn't. You feel isolated. [**PT(B), p.10**]

(Jean) .... Like, I've got about half the division– they're so threatened by it, and they see all that has to be done in September– they're seeing all these changes where they're just saying, "Let's make a step, and I see what this is". I'm not what Paul is, but I've made a step away from what I was before I came here, and I think that's all you can do. And maybe what Nancy feels comfortable with I don't yet feel comfortable with, but I'm moving that way, and that's all anybody can do. And if you take too big a step, then you're going to be floundering again.

(Nancy) Besides, I think, when you read something, you probably don't integrate it because you don't have time. But when you come to a group like this and you DO it– (Jean) 'How do you. do that?'– (Nancy) That's– you're likely to try it again because you feel okay about it. [**PT(B), p.13**]

(Penny) This is sort of a sidetrack from what we were talking about– it's something that you talked about earlier, and that is being able to take something that the child notices during the day– a spontaneous thing– and to follow that a

little bit, and to not just feel so closed like, we're in a unit on magnets right now, so don't think about that crystal that's shining in the back of the room and making rainbows all over the place. We did that! I have these crystals hanging from the structure in the back of the room, and one day there were such rainbows on everyone! And they were so excited about that. And we had tons of stuff to do in our unit– whatever– but I felt totally comfortable just saying, "We'll just set that all aside for now" and look at this and say, "well, why does it turn all those colours?" I think you had mentioned that earlier, about just being in a unit and wanting to take these little branches? It's so incredible where those branches take you, and you may have no idea when you start off, but you end up getting to these great places, and I think there's something really– and if you're comfortable doing that– I don't know that a lot of people are– but this type of in-service HAS made, at least for me, my feeling comfortable in doing that. **[PT(B), p. 37]**

****

(Int.) **.... The rationale for supplying and providing support for the innovative in-service this year and next for the Ministry was to raise teachers' comfort level. First question is: is your comfort level something that needed raising before this sort of thing came around?** (R) Yes. (R) Hmmm.

(Int.) **Before it happened, you weren't really comfortable with doing science– is that right?**

(Wendy) I wasn't really comfortable in knowing whether I SHOULD be comfortable! (Int.) Okay. Tell us some more about that. (Wendy) Well, I just felt from the beginning there are a lot of things new this year that I'd never touched, but there were a lot of things that I had done not in the same ways but they didn't get done after all. As I said, sometime you feel that you are not doing a bad job after all. And I like the idea– I quite often use science as a basis for the language across the curriculum– or whatever– across the curriculum.

(Int.) Sharon and Margo– you haven't said too much this afternoon– you've nodded your heads every so often in agreement.

(Molly) Well, I think that was when I read the questionnaire– I just got it in my mailbox yesterday. It wasn't until this morning before school that I read it over, and when I read that question that was it for me– 'comfort level'– and let's face it– if you're not comfortable, you're not going to learn, or you're not going to be able to teach and your students aren't comfortable, you'll always to have to remember, right from square one, they're not going to learn anything at all.

(Int.) What makes you uncomfortable about it?

(Molly) Well, last year was my first year in a classroom, and I find you're very overwhelmed with all the responsibilities, especially going through that first year in science was one of the weaker points, I felt. I was just– let's say my comfort level was not that high at all– particularly in science. And this had really made me feel more comfortable and more confident, and I think that each year that will apply.

(Shelia) I guess I just feel the same as Margo– the idea of being teacher– having so many things that you have to absorb at one time. And sometimes thinking, 'Well, this will have to do for now.' But now I feel I have a little bit better idea about a feeling of science and a little more confidence. I know a lot of resources now that I can go to. **[PT(B), p. 44]**

(Int.) So, many of you, then, had a comfort level that you were not really satisfied with when you came into a project. **The final question– has there been any change in that comfort level? Some of you answered that already.**

(Ann) I think an increase in enthusiasm– like, as you say, putting something at a priority as opposed to being kind of put behind because you were so enthusiastic about ANOTHER area, but realizing the potential and fun and enthusiasm that COULD be generated. And that's really a plus for me.

(Jean) It means that you don't HAVE to have all the answers, and you can be looking for them, and you can be using the resources for learning in the library after you come up with some questions, maybe, that you can delve deeper into the subject in the library. And use some of those resources there. I don't feel now that I have to know why magnets work or this or that– I can just enjoy using them and see how they work. And then if I wanted to find out more, the kids have paper questions and we can turn somewhere else for the answers. But, you know, I've always been comfortable TELLING the kids that I don't know everything, but I would kind of steer away from subjects that I didn't (much laughter!) Grade 8 science (inaudible) that was languages, and math and science were not my strength at all, so I find it very intimidating when I have to do things that I thought– you know, something very scientific to it. **[PT(B), p. 46]**

****

(Jerry) I think, with myself, part of it was the resources, but part of it was "Where do I start teaching science?" Like, there's so much that you CAN teach, but how do I begin to teach it in a way they'll find interesting, and I'll captivate their interest and that they'll LEARN something? And I think this in-service thing here really helped to– it showed that you can basically make science out of anything, and it teaches a lot of principles which, on the surface, somebody walking in would say, "Well, that's kind of silly; how can you learn anything just by doing that type of playing?" But it taught me that you can learn a lot of scientific things just with everyday utensils or whatever if you spend time with it.

(Connie) But, don't you think that's why this was good? Because we had a chance to play with them? If you had gone to a workshop and someone had just rattled off some of these things, you might have gone home shaking your head. But having actually gone through them and just seeing yourself ... I think that's what I needed...to actually go through them, and see and, at the end, if you didn't have all the answers, I think most of us became comfortable with it. It was all right if we didn't have all the answers and could say to the kids maybe they could go on and look for some of these things and come back and tell us. But I think that was the big thing, that we took the time to go through the activities. And I think that, unfortunately, in a lot of in-services, you don't TAKE the time to go through and do the things, and then I don't think you incorporate them into the

classroom the same. I think other teachers who get involved with the science– unless they go through the activities a lot the same as we do, I don't think they'll benefit, and that to me is the big benefit of getting in a team like this, is that, even though you've had to put in a lot of hours, you DO get a lot more because you've gone through it and experienced it.

(Int.) Is it like it is for me, Connie, I wonder, from what you're saying? I find, for example, if I get a camera, and I sit down and read the instruction manual, I've still got a lot to learn about the camera, and it's really hard to connect up what the instructions say with actually working the thing. On the other hand, if I pick up the camera and leave the instruction book in the box and fiddle around with the camera, I begin to figure it out. Then the instructions– I can go back to them and it makes some sense for me because I've had a chance to work with it to see what it'll do and so on. Is that the kind of thing you're talking about in the purpose of these activities?

(Connie) Well, I think, too– and it doesn't necessarily have to be science– but I think there is an awful lot of paper that has been coming down the last few years and, you know, some of it you read and some of it you don't. And that's the advantage of being here at the ground level is that, you know, I believe that people have gained much more than people who will just gain it as paper, and they'll say, "Oh, yes, that's very nice", unless there's somebody right there who– they can come into their classroom or they can expand this group. That's how I feel about in-services, myself. I was at an in-service the other day, and they handed us the document and we went like this, page-by-page-by-page, and I thought, "Why am I here?" And I didn't gain from that at all! [**JT, pp. 8-9**]

(Connie) I think the more you do it, the more comfortable you will be with it. Certainly, I haven't done as much with it as I'd like but, as I did it, I became more comfortable and–

(Int.) The primary teachers were saying yesterday that they thought the major payoff for them would come NEXT year because they would have time to work on things this summer, and then begin to think about activities they'd done before in different ways– now, in terms of more hands–on kind of focus– but they really did need time to integrate it with the other things because–

(Terry) What Alice was saying about using outsides that's the same thing I'm thinking. What I'm tossing around and would like to talk to these fellows and Brian and Doug and so on, I think– how long should you plan– of course, there's no set and fast rules to that, either, but I'm looking at would you plan for four–week sessions or– and, of course, you're looking at whether you're working half days or whatever. You've got to look at how much time you want to spend on it, and so on. But anyway– but, for myself again, I've really got to map out something to say, "Okay, I'm going to work in 4–week sections"– or 6–week– or whatever it happens to be, and I think it'll work out beautifully then.

(Connie) But are you building enough flexibility into your program if it goes longer?

(Terry) Well, that's the other problem – it's not that I don't, but that's the problem I can see– that my personal shortcoming is that you DON'T– and if you do it

that way– you don't capitalize on things the children become interested in right at this present time. But at the moment I don't feel comfortable enough at it to go at it that way. But I do know of other people that do and have and have a whale of a time, and do a fantastic job. The kid brings in a bees' nest tomorrow morning or whatever– I mean, I don't know where I'm going to collect any dandelions!

(Alice) The New Ministry document doesn't go by themes at all. It's not prescriptive the way the Grade 7 and 8 one is, under certain things. It just says, "Children are given the opportunity to..." and then those three areas: life science, physical science and the earth– and science. So it doesn't really matter whether you're– you know within a theme. But the children have the opportunity to see– and for me that's what we did here. We were having opportunities, too, and we probably could go through those and go back and match them up with the objective in that document, and cover half of them. **[JT, pp. 45-46]**

5. Teachers' Views Concerning the Future Directions of the Project

(Int.) **...– if the project were to continue next year, and we now know it will– would you participate in it?**

(Many Voices) Hmmm! (R) Yes! (R) Definitely.

(Nancy) I think there are also other areas that you mentioned that we might have looked at that we haven't done this year, but I also wondered if we could work on a unit, theme, whatever, and integrate it, and see if we couldn't all come up with activities. If we had a topic to take it away, and then come back to it and share those activities on one theme, so really we're writing, and we would have something that we'd be working on together, but also something to take away. And what I mean by that is that we put whatever topic in the middle, and then we think of the activities, be they language, math, science, that you might do around that activity that we could try out in our classrooms. **[PT(B), p. 41]**

****

(Connie) .... Like, what I would like to see for next year is that people take ideas on a particular topic even if we– and try them in their classrooms for a month. And when we come back, sort of say, "Now, these things work really well". And we group everything together and say, "Now, this is starting point, and an extension to a certain extent", and then another month or whatever take another topic, whether it's the balance or whatever, and people experiment and do– like, I'd be interested in that kind of sharing that, you know, if you took five or six topics and you said, "Okay, let's give them each a month or something and try as many different activities as you could, and come back and write something down". I guess that's really where I saw myself wanting to go, and I think I still have that– like, that's where I want to go. Like, you were talking about batteries and everything; I would have to do an awful lot and still need the expertise that was there to feel that I could do something in batteries, and whatnot.

(Phil) Yeah, I think I would like to go in that direction, now that I feel comfortable with the kinds of things that we've done this year. To have other people come in and maybe, over the course of a 3-hour evening, have five or six people present a unit that they've tried in the classroom, with handouts that you can literally take away and try and extend and practice on your own in the future. And, if we all did that, we'd end up with– you know, not all the groups here, we have 15 or 20 units– [**JT, pp. 14-15**]

(Frank) Yet, I think the point Connie was making earlier about the individuality of– individuals participating in a hands-on workshop– not only that but participating as a group over a period of time so you get 'ownership' of the program. So often– that happened with thinking skills– . I was with a group for two years, and it was great, and we were quite willing to continue but we couldn't get support for it. It died, and I think "Thinking Skills" died with it to a degree. It wasn't a large group but I think it might have expanded over the years. I think, with any area of curriculum, we have like the science, but I think it's something we should just do for a year or two and forget about it, because otherwise there'll be huge demands put upon us, new emphasis, and you sort of lose sight of it, then it falls apart – I really do think it starts to fall apart– it starts to fall apart. Collectively, there's greater interest and I think, as individuals, you need somebody to sort of kick ideas around with, and I think that was one of the important things. And I guess– we have to realize we only had a limited amount of time and a lot of things to do this year. I guess there are a lot of other areas we'd like to explore, perhaps, and take different tacks, but, you know, that's somewhere down the line. [**JT, pp. 14-15**]

(Frank) Yeah, one of the things that I'd like is to tape what's going on in the classroom. You know there are some horror stories, but ...

(Int.) You anticipated my next question!

(Frank) Yeah, it's too bad, but for my own personal use I could videotape what's going on, and it's sit down later when I've got some time at night and stick it in the VCR and start looking at it. Then you can start analyzing it. [**JT, p. 40**]

(Int.) Okay, well there's probably still a possibility if you wanted to do that. I don't know what your timing's like, but we've finally got the equipment now. How about other people? How would you feel? You see, one of the things Doug and Brian were thinking of is that we'd begin to tape these activities, bring them back here and talk about them. Alice, you were talking about beginning to observe and analyze kids, and I think one of the elements of evaluation is very much that kind of thing. If you begin to look at the activities and say, "Now, what is going on? What are these people actually doing? You know– are they trying to get inside their own heads to figure out what they see what is going on? I think that's often what we try to do with kids. You know, we see the science and we understand it from OUR point of view, but then they ask us a question and we realize that that's– OUR understanding is quite different from theirs and we try to figure out how we could connect the two up– so that was part of the concern. Now when the suggestion about videotaping came up– I've got that on tape as

well– and there's this embarrassed laughter that ripples through the room. You can really feel it– there's kind of an edge on it. Would you still feel uncomfortable? Or do some people still feel pretty uncomfortable with that?

(Alice) I think we have all been video-taped at one point or another in your routine, you know– different things. It wouldn't bother me in the least. With the kids, if you'd be lucky enough– [JT, p. 41-42]

(Frank) .... what I'd like to be able to get– to sit the, I don't know, if you'd get, like, a wide-angle lens that would serve, you could sit back and take in the whole room. And then mostly for your own purposes or it might be used for scaring with groups such as this.

(Alice) For video, you've got to get up pretty close to– if you don't get right up close–

(Frank) Well, I'm just wondering if– so you wouldn't have to worry too much about an operator– I don't know, with the state of the art in terms of a wide-angle lens, would it give you the–

(Int.) But that's the kind of thing the group could work on next year. You see, you could be saying, "Well, you know, here's what I'm interested in looking at in these activities." Somebody else might be focussing on language; you're interested in the pattern of activity in the classroom while you're trying out one area, so a wide-angle might do YOUR job. Somebody else might want to zero in on a discussion with three or four kids around a table somewhere. So, different approaches would be suitable for– [JT, p. 42-43]

(Alice) Most of our schools have videotapes, so the kids are operating them, and they're doing it in our drama classes and, you know, they're very comfortable with these videotape machines or video-cameras.

(Linda) It gives the class a chance to have these videotapes a couple of times.

(Frank) No, I don't see any problem with the children at all because, you know, once they get into the activity, they're going to forget about the camera, and– [Many voices]

(Terry) After five minutes you forget the thing is on.

(Alice) – and they just roar and laugh. We done it lots of times. And you show it to them after and everybody just laughs for a good whole hour. You just break up. [JT, p. 44]

(Alice) I feel I'd like a formal kind of a timetable, a time line, where we were going. Like, this year it was great; we never really knew until we got here exactly what we'd be doing, but we kind of were part of it, and mostly it was someone else was sharing with us, and we added to it as we got into it. But maybe if it was thought about in a more formal way– the direction that we would take, more specifically– maybe it would be more meaningful the second time around.

(Int.) **What could you tell us about direction for next year, then?** I mean, this is probably one of the last things we need to think about. What should–

(Alice) (inaudible) meet here or get together early to talk about what we thought our needs were. And prioritize our needs.

(Otto) Could that be done– could you do that once in the fall and then not meet again until after Christmas?

(Alice) Or even if you did something in the fall, and you did a need that you could implement with the fall weather the way it is– so much science can be done in that first September/October– the natural science and the life science.

(Sandy) I wouldn't want to be too formal, though– I enjoyed the flexibility. I think different ideas and input of all different sorts–

(Connie) But, see, I go along with Don's need. I'd like to sit and help Don, or pick Don's brain and, you know, come up with something at the end that is in my box, and I can always add to that box.

(Frank) I wonder if we could have– like, I really think it's important that you have the group continue. I like tossing ideas around with other people. Sometimes it's a sort of catharsis. I think we get a lot out of it from many different aspects. Perhaps we can continue having presentations made part of the time, but also a sharing time, if you want to call it that.

(Alice) I only meant like, formally, that you'd plan– like, THAT would happen. That you'd have a plan of action, but not quite formal. I didn't mean, you know, a rigid–

(Int.) So the group would know at the beginning what direction the whole project was going to take for the course of the year.

(Alice) Yeah. Like, that might be what you needed. That would be the form, and we'd all planned that so that we know where we're going. **[JT, p. 47-48]**

6. Further Matters Not Covered in the Questionnaire

(Int.) .... A final thing (I keep saying that). **Those are my questions and my concerns; what have I missed? What things would you like to say that have been left out or ignored either on this paper or that we haven't brought up this afternoon?**

(Nancy) Well, maybe somebody should tell all of our board and the Faculty of Education and anybody else that we really like working together, and couldn't we do it again?

(Betty) Or continue?

(Marnie) Well, it's been a totally invaluable experience. Like, it's– and it's something that, no matter what the funds are, it shouldn't be discontinued.

Like, I would hate to see a group like this discontinue because of lack of funds. There HAS to be a way! [PT(B), pp. 47-48]

****

(Int.) .... **I wanted to leave a space and a time for you to pick up on things that hadn't been addressed by this or that we haven't talked about this afternoon.**

(Otto) I recall Paul saying that night– which was it, illustration night– or maybe it was one other night– that he didn't evaluate. He saw his role, I guess, and he was fulfilling it in his own eyes: it was turning kids on to science. He said, "I don't evaluate."

(Alice) Not formally, he didn't– he'd informally evaluate. He'd have them write down what they got out of it–all the ways, and he'd tabulate that. He had that many questions

(Int.) See, we could say to him, "Well, you have to do something, because how could you tell they were turned on?" You know, I mean, do you just do these things and then sort of walk out the door and ignore the reaction to it? As long as he's beginning to pay attention to that, then there's some kind of evaluation going on.

(Alice) Remember the sheets he gave out– he showed that at the beginning. He only had one or two observations, and then by the end of exposing it to the whole class in different groups, they had like 101 different observations in the one area– he said, things he never thought of– and they had to be turned on in their thinking or they wouldn't have made those observations.

(Int.) And he wouldn't have known they had, either, if he hadn't evaluated, right?

(Alice) And that was his evaluation. That's what he was doing, like he reads through those sheets.

(Jack) But then, carrying that over– translating that into report cards, you know, I think is– I don't know–

(Don) I think you can couple it with attitudinal changes. A lot of parents, you know, like to know if their kids are turned on and they enjoy what they doing, and most likely are doing it at a satisfactory or good level. But I guess what Paul was doing was less of a formal type of evaluation [two voices]–

(Phil) Yeah, well I think you're looking at things like "Can they classify objects? Can they sort them? Can they set up an experiment?–"

(Alice) – But more in line with the document–

(Phil) – And you can observe them and write comments in the report.

(Alice) Do they investigate? Are they investigating? Are they observing? Are analyzing? Are they trying to find out? Or what DO they find out? How do they find it there?

(Phil) Can they keep records?

(Don) Skill development.

(Alice) Do they go from that on to the next?

(Int.) See, there may be a dimension, if you wanted to put them in kind of an evaluation situation too, I think, where you set up an activity FOR the purposes of evaluation. Often these are used simply for the purposes of getting them to learn certain things, but you want to see HOW they've learned to operate with hands-on, so you might sit down and watch how kids go– from various kinds of kids, or various teams of kids– go through a series of activities you've set up for them, and use that as part of the basis of your evaluation. Now, the trick is to figure out how to get from that to a report card mark, isn't it, because–

(Alice) No, in your head, really, think about your class right now. You know without opening up your records– you KNOW that the kid is and 'egg-head'– and that's not changing. I could probably open any of my records and put down A, B, C, and go back– add them all up , if you do that– I haven't done that for a long time. You KNOW if they're an A, B, or C. Or if they're failing. And, if they fail, like, how many really fail them, you know, because that kid didn't have the ability and some teacher will say, "Well, I mark them on effort" because they would have all "D's" and that wouldn't give them a very good self–concept, so– [**JT, pp. 50-51**]

C. Assessment in the Second Year: Teachers Write About the Science Club

#1. Connie

The Science Club

I remember last year when I felt very uncomfortable sitting around the table, feeling I knew very little about science. I still feel my knowledge of "scientific data" is weak but my comfort level is much higher. It has enabled me to look for ways to include science activities in my class. It has opened my eyes to seeing the potential of activities in a classroom. I have seen the students' interest take us further than I had planned. Through some of the activities we have discussed, I have heard the enthusiasm of the children as they do these things. Often heard how they've tried them at home.

I feel much more satisfied with the program I am offering even though I know I have a longer way to go to get a full program. I think the comfort level of being able to slowly implement things, of having others say, "I've been too busy to get this done",

has been very reassuring. No one needs that added pressure of constant evaluation & in the long run I am sure the results are better.

I'd still like to spend at least a couple of nights in small groups brainstorming topics so that at the end we might have 4 or 5 topics for each grade with a number of activities one might try. I guess this is my lack of science still coming out.

#2. Ann

Science Club

Participation in the Science Club during the last 2 years has been one of the three most rewarding educational experiences of my thirteen year teaching career. The other two ongoing experiences which continue to have similar impact on my teaching philosophy and skills have been Education Through Music and Math Their Way.

Through attendance at the Science Club meetings I have learned how to BEGIN to operationalize a philosophy of teaching science. Being naturally a more verbal and theoretically oriented person, Science Club has forced me to extend my own (undeveloped/repressed) abilities to enjoy experimentation and play. I have accepted that learning to ask the question is more important than having the answer, for myself as well as for the children.

During the past year I have been directly involved in the presentation of pure science related in-service programs. This interest and enthusiasm I attribute directly to my participation in the Science Club.

I am interested in the development of a scope and sequence outline for science which supports and extends my knowledge of active learning and thinking skills.

At the Science club, I have sincerely benefitted from a) opportunities to share and discuss curriculum-related ideas both formally and informally; 2) opportunities to participate in hands-on science activities; 3) the opportunity to develop a support network of people, resources and materials.

I am immensely excited about my continued involvement in the Science Club. Thank you, Brian and Doug, for your outstanding leadership.

Signed 'Ann'

#3. Dianne

Notes on "The Science Club"? 1988-89

I joined "the club" in a special role as a graduate student participant-observer. The first meeting felt a bit like a "make and take" inservice. We put together insect observatories. Over the year, though, a number of things have happened which have changed my perspective on science education and on how to improve education. Over the next few pages, I would like to touch on a number of issues: first, how I grew into my role as a videotaper; second, how the ongoing in-services have changed my perspective on science education; and third, some final comments on my role in the club.

I did not begin videotaping until early November. By that time, I had a pretty good idea about what was going on in the Science Club and knew what I wanted to focus on in the classroom. That's how I began. I have been surprised a number of times by the things children have told me (or that the camera has simply picked up). I realize that they have far more innate ability to make sense of difficult science concepts than I had thought. The most successful videotaping sessions have been those that taped children in the process of discovery– simply turning on the tape, moving around the classroom and interviewing/questioning children as I go. The least successful sessions have been those in which the children were primed to perform for the camera, either by having been given time to "practice" making their discoveries, or having prepared some type of dramatic presentation. I have a feeling that children expect to "perform" if they are presenting a play. They seem to ham things up and forget about the point of the exercise, in favour of getting approval from their classmates.

The teachers who have allowed me to tape in their classrooms have been terrific. Although they are at many stages in terms of how they incorporate science into the classroom, they have all bravely taken the step to open their doors to recorded observation. I really appreciate the trust they have put in me. As I pass through classrooms in this way, I can see the value of the Science Club for its members.

There is a certain amount of selectivity in the club to begin with. Anyone who is willing to give up one evening a month for two years has expressed more than a passing interest in improving (science) education. I am, therefore, probably observing some of the best teachers in the system anyway. In spite of that, I think that what I have observed is a lot of experimentation by teachers and the growth of their programmes. If I could use two sample teachers, let me talk about Wendy and Nancy.

Wendy seemed to be a silent member of the group for the first half of my observation year. She asked me in February if we could set up a videotaping time for April. When I finally did get to her school, five teachers were involved in the "Under the Sea" unit. I was asked to tape in each classroom. Wendy's classroom was the last of the five that I entered. Although her students were doing essentially the same things as the other classes, what Wendy had incorporated into her room were centres at which the children could explore buoyancy and periscope vision, as well as more traditional explorations of things that lie under the sea. I was amazed by the difference in her students' level of involvement in their activities compared with the students' commitment to their work in the other classes within the school. Wendy may have always incorporated centres related to themes but the science base of her activity centres suggested that the "Science Club" activities were becoming an important and natural focus in her classroom organization.

I first visited Nancy's class in December. She seems to have a strong activity based, science based programme established in her classroom. Unlike in Wendy's school, there seems to be support for Nancy's type of programme within her school. Whether other teachers are involved in active science based programmes because of Nancy's leadership and enthusiasm, or whether the programme seems to be so well established because of the support of other staff members, I am not sure. I think that I have seen a similar thing happening in Doug Farquhar's school. His enthusiasm and leadership in science education have helped to create a strong science programme within his school.

What will happen in Wendy's school? She is modelling science based programming in a quieter way than Nancy but perhaps how she is ready to take on a stronger leadership role. It would be very interesting to follow her into a second year.

Now that I have followed the "Science Club" through a full school year I can see its benefits and am very enthusiastic about its success. The teachers in the club express a great deal of enthusiasm about science and about education in general. They are

willing to try ideas and, probably most important, because they have come to know and trust one another, they are willing to risk things with one another. I wrote science curriculum for a Toronto school board two years ago. Having talked to a number of teachers in that board, I realize that those materials will sit on the shelf largely untouched unless the board is willing and financially able to make a commitment to an ongoing inservice programme similar to the one I have been involved within Frontenac County. The most important thing that I have gotten out of this experience is the insight and confidence to promote long term in-servicing projects in science education to whatever school board next employs me (unless, of course, it's a Frontenac County school board).

It has been a privilege to be involved in the Science Club as a participant-observer. I think it has greatly enriched my M.Ed. experience. For future graduate students involved in the in-services, I would recommend getting involved in videotaping. It has been an excellent way to gain teachers' confidence and to learn a lot about how students "science" (the term that one little girl used to ask if she could study worms).

Signed 'Dianne'

#4. Paul

The Science Club - Writing Activity

Reflections, impressions and suggestions relating to the Science Club. Prepared for the Science Club by Paul, May 1989

1. Preamble

Adam signed up for softball for the fourth year in a row– even though he's one of the less skillful players! I attend almost all of his games but have vivid memories of why I disliked the game as a child. As an educator, I find children's ball still without any redeeming features. I can't help drawing parallels between what I see happening on and around a ball diamond with the worst that goes on in classrooms!

I mention this because, just prior to the first game this year, I had been re--evaluating my thinking on observing, tracking, evaluating, and reporting, and had just re--explored North York's book on "Active Learning– Teaching and Learning in the Junior Division." As the game progressed, I found myself watching, listening...and thinking. I began focusing on trying to discover why Adam liked the game. It was, I suppose, the influence of Brian's probing questions about what and how children are really learning that made me focus on searching for just what it was about the game that the children– especially the non-jocks like Adam, were getting from the experience.

I'm an educator, and a parent; I'm watching the game first hand, and I still have difficulty identifying what it is I should be observing and what lessons are really being learned. What if I were a parent, the ball diamond the classroom, and the coach the teacher– just what kind of a reporting system would have even the remotest chance of getting the educator, the child and the parent on a common basis of understanding?

What should we really be observing? What's really important to children, and how do we report to a parent who wasn't a party to the experience? That's probably one of my biggest dilemmas in education! Ann's comment at the April Workshop, "I think I

know what the children should be doing with the materials and I'm not sure it's the right 'stuff' for this to happen", sums up the situation very well. The difference is that Ann's reservations were largely resolved by the end of the day because of all the support systems that are integral to the Science Club, whereas my quandaries re-softball and all its educational and child-related implications remain largely unresolved. However, after being part of the circle group discussion which drew together our thoughts, feelings, and proposals about where our Science Club should beheading, I have no doubt that this type of educational challenge would be well within the realm of discussion next year.

2. Science "Did" Happen Here .... And Much More, Too!

In my mind, the greatest merit of The Science Club is that no one need break new "educational ground" alone! The shared discoveries, peer coaching and networking available through the group has gone along way indeed to raise the comfort level, experience and enthusiasm of the group.

A further example might help illustrate the importance of shared experiences in professional development and the evolution of program implementation. Two years ago, after watching my son come through "Math Their Way" with a local teacher I very much respect, I took the "Math– A Way of Thinking" course in Kingston (where else!!!). Two years later some other boards are still "fiddling" with Manipulatives Math in the Junior Division– doing what I call the "Splash 'n Dash" type of in-servicing. It's showing little impact on the classroom for new enthusiasts and certainly makes no attempt to meet the needs of the committed. Within my own school, I'm flanked on either side by textbook programs. This isn't to pass judgement– my background has been upper Junior and Intermediate, subject-oriented and teacher-centered– but rather to emphasize the lack of opportunity for shared growth. When I compare the implementation problems of my isolated classroom with that the the Primary Team's "Math Their Way" implementation, with all its peer and Primary Association support systems, the value of shared growth cannot be underestimated. Because of the Science Club and Part I & II, I'm much more inclined now to bounce my problems off the Primary teachers. This produced an added bonus which none of us expected– my need for their math experiences and their interest in my science produced a common meeting ground– children, learning styles and teaching styles– we had a lot more in common than we thought!

I've just had the opportunity to view a four-part series of V.C.R.tapes produced by the Metro Toronto Boards called "Making It Happen". The series interviews Metro teachers about the problems and solutions they encountered while they went through the transition to Active Learning. If you haven't see the tapes, they're well worth viewing because they add validation to what we've been doing! The "Kingston Connection" (Science Club and Parts I & II) has been, for me, this and much, much more when it comes to "Making It Happen". I sure am grateful for the profound impact Kingston has had on my personal and professional growth in areas way beyond the boundaries of science!

Having finished this section of the writing activity, I went to bed contented. A week later, as I'm re--copying this into semi-legible handwriting, and it's just about bedtime again, I'm trying to re--formulate some thoughts I had written for the next segment– Challenges and Directions for the Club. I'd just gotten permission from my principal to attend the end of June conference. Where was I in the sixties when these men were the "movers and shakers"? Struggling through my first two years teaching! (Patience and Penny!!!) Where we've been, where we are, and where we should be going– the timing couldn't be more perfect for Nancy and I, stepping into Part II, and Liz Evans, taking over Doug's role in the Club.

Nancy, Phyllis, Dick and I have seen the Science Club evolve in a manner quite similar to that of the P/J Science, Parts I-II. As we examine the 80's science revival through the experienced eyes of the '60's people, it's equally important, and critical in timing, with Doug's sabbatical, that we focus our efforts on gaining more insight into the "magic" behind the formula of the key players– Doug, Brian, McArthur, and Frontenac County–which makes Kingston the leading edge of the revival for Eastern Ontario! One only has to look at the Lighthouse Project as evidence of this fact! Kingston, being the site of the June Conference, should turn a few Toronto eyes as well!!

Before getting back to my re-copying, one observation re- the "magic formula" to get the ball rolling...I can't help but be impressed with the working relationship between the University and the needs and directions in the field. During the first week or so of P/J Science, Part I, I couldn't get over the professional license given Doug and Brian (with a rigid course outline the magic wouldn't have developed– personally, I've never worked this hard on a graded course, but Queen's P/J Science Parts I-III are for me not the"grades"!) And, most currently, I watched, firsthand, some of the mechanisms of this partnership at work as the June conference took shape. With this kind of communication channel, it's no wonder Kingston's on the leading edge of "Paper-to-Practice"? Science is Happening Here. And It's Exciting, Too!

There's much more to the magic, but that's a start!

3. Challenges and Directions for the Club:

To my mind, one of the greatest challenges facing the Science Club is how to incorporate new members without losing what we've worked so hard to attain. After the April P.A. days, I think it's evident that most of the membership has come to realize that we've reached the stage where we're now in-servicing ourselves– no "Bibles" from the head-sheds, no "gurus" from the program departments, just (thankfully) grass roots growth which comes from the ownership in the shared experiences of the group– set in an atmosphere cultured by people who demonstrate a trust and patience for the process, not the product! Without Doug, Brian and Skip, we might just be another document sitting on a shelf.

The challenge is how do we transfer this ownership to new members in an encouraging, exciting and inviting format? They must feel part of the process– not the recipients of an "elusive product" called Science.

The following suggestions are for the purpose of generating discussions as to how this challenge might be met.

4. Suggestions:

a) Adopt Brian's idea of 2-3 meetings in close sequence early in the year– that, I think, is what got the Part II group to jell so quickly!

b) Implement a Who's Who Board for the year.
   i) Prior to first meeting, send out profile cards (cut to fit the Whole Language Pocket Charts). They might contain passport photo, name, phone numbers, school, grade, 3 favourite themes, 3 areas I'd like to develop this year, what I'm working on this term, etc.
   ii) Includes new, returning, and organizing members! And It may take 2 charts to hold all the cards, but well worth it!
   iii) Who's Who Board posted for EVERY session and updated regularly.
   iv) For the first meeting, this could be used for a Host/Guest pairing.

c) Create a separate, ongoing pocket chart for:
   i) Shared dilemmas or discoveries
   ii) Networking. Help I need___. I'd like to visit a classroom where___. Note: It probably would take some "Salting" the chart and a commitment to providing the dialogue line to make it happen, but I think it could really open channels for new members.

d) First session: Among other things would include;
   i) Perhaps a video collage of our experiences to date for the new members.
   ii) A "pairs" activity which will:
   – have immediate transfer to a Sept./Oct./ classroom
   – allow for pairs, small, then whole group dialogue
   – provide potential for divergent methods/materials,and expansion of activity into integrated Theme - Purpose: Through Teacher-Teacher experiences, set in motion the mechanisms for "growth through shared experiences." Note: Slugs would fit the above criteria very well!
   iii) End first session with enough experience and dialogue for new members to feel comfortable in expanding their "shared experience" to the classroom, i.e., teacher-child, child-child. Note: Any creepy crawly could replace slugs.

e) Second session: Among other things would include:
   i) Shared dilemmas, discoveries and networking time,
   ii) Continuing The Slugs "shared experiences" by focusing on the child. This would set the tone for a model of "growth through shared experiences" or self in-servicing, i.e., club-classroom.

f) Third & subsequent sessions: Among other things would include:
   i) Sharing time,
   ii) Selection and ongoing involvement in one or two areas of focus. (From the Who's Who Board, organizers could identify areas of interest from which to develop work teams).

g) Areas such as the following might emerge:
   i) Kits– materials (suppliers, testing) storage, sharing, pupil experiences, etc.,
   ii) Integrated themes/units,
   iii) Equipment and materials– assessment, new uses, etc.,
   iv) Sciencing from junk,
   v) Science through literature– locating, testing & reporting/sharing new titles (expanding our Club Library?),
   vi) Storage ideas for Active Learning classrooms,
   vii) Science beyond the classroom,
   viii) Exploring better ways of Observing, Teaching, Evaluating and Reporting,
   ix) Resources and approaches for increasing awareness of environmental issues. Note: The focus is intended NOT to be the "development of units, kits, etc." BUT RATHER what children do with our resources and methodology and the implication this has on our goals and directions– individually and cumulatively!

h) A key element in making the concept of "focus teams" work would be to have in place, by the third or possibly fourth session, a well-organized

network channel whereby resources and ideas would be direction towards or requested by particular work teams.

Well, so much for my re-copying; the original was five pages! Hope this will be of some assistance.

Signed 'Paul'

#5. Marnie

Science Club Reflections

This is my first year full time in several years and my first year in primary-kindergarten. I have enjoyed it and do not regret the move. However, it has probably been the busiest year of my life. I have always looked forward to the Science Club meetings, no matter when, because I knew it would regenerate enthusiasm in new or rethought ideas. In a year such as this one has been, they were especially anticipated (and not because I didn't have anything else to do).

I have always believed myself to be fairly comfortable with Science but this group has certainly added to this feeling. Being able to freely share ideas and successes and failures with your peers and get their ideas is an invaluable experience. The atmosphere is created, I'm sure, by the fact that it is of genuine interest to all in the group. Doug and Brian have also been instrumental in creating this atmosphere. As long as this support system is available to us, we will feel far more comfortable in experimenting with various ideas, etc. in our classrooms. This is, I believe, one of the primary functions of the group.

I have enjoyed doing Science activities with my children and love to see their curiosity in action. I sometimes have difficulty in being available at just the right moment to extend their learning. This is perhaps the most frustrating aspect of teaching. With 25 children it is very difficult to "be there" at the optimum time.

My most enjoyable classroom experiences this year have been when I have handed over more of the control to the children– i.e., when I have used more of THEIR ideas. They were thrilled and needless to say the results were far better. I will continue to do more of this, I hope. My comfort level with this gets better each time.

Whatever format is chosen for the Science Club in the next few years, I'm sure it will continue to be a gathering of enthusiastic, energetic individuals who enjoy what they are doing. This is what creates the atmosphere that is so great. One aspect I haven't mentioned is that of being made aware of resources and materials available. It is impossible for individual teachers to be aware of everything that is available but, through sharing, we can help each other.

I hope you can make sense of this as I have written as ideas have come into my mind. If it hasn't come through loud and clear before, I thoroughly enjoy the Science Club because it is the one meeting I can go to exhausted and come out feeling rejuvenated and eager to try new ideas. I would NEVER want to see it discontinued. Perhaps in the future we could start putting some of these wonderful ideas in print in some way. We "made a stab" at units this year but maybe we could do it in earnest. If the size of the group is to be increased, maybe the "old-timers" could share some of their successes with the new people, in a very non-threatening way.

What has been done to this point is terrific and I'm sure it will continue to improve.

Thank you for all the time and effort all of the organizers put into this project. We certainly appreciate it.

Signed 'Marnie'

#6. Jack

Science Club– A Written Comment

I have enjoyed my time spent with this group. We have grown together and are willing to share ideas and experiences. The materials given to us are very good to have as well as the 2 books. I have become even more aware that children need to do things themselves, hands-on. This requires structure and planning.

One weakness is a lack of written materials– each activity could have had a one page summary. I did make some notes but I do forget things.

Some activities were repeated too often, e.g., bubbles.eager to bring in consumable products or supplies.

I enjoyed doing the SEEDS unit with my students. It is well balanced and prepared. A.V. materials, hands-on, & student text.

Being in a portable classroom is a major problem– no water, no hallway for extra space. Everything you want to do requires extra planning, time & effort, and the carrying of supplies or materials, etc. There is no room for storage of materials.

I feel some of next year should be given to writing down a brief outline of 'units' materials, some suggested activities and the necessary language to be taught, e.g., science terms, so there is content, not just experience, and some evaluation techniques, I SUPPOSE.

Also lots of community contacts, people & phone numbers, so that units of work can have guest speakers.

A lot of our work has been on PHYSICAL SCIENCE– perhaps we could include ideas to let children experience nature– animals, insects, etc., constellations, space, electricity, etc. There are many areas we have not covered.

Thanks for everything.

Signed 'Jack'

#7. Jean

May 23

Dear_____

If you remember the last time I wrote I told you about the Science Club I attend once a month. Yes, it's hard to believe, given my background of very little science in high school. Yes, I know we taught a workshop featuring the board document on "Sound". However, that was in a very comfortable format for me at the time. Everything was laid out from materials, objectives, method and evaluation– a very safe starting point for me. I was also very comfortable demonstrating what I wanted the children to know and then putting notes on the board or fill in the blank stencils. Evaluation was easy– their notes and test scores.

Now, because of the Science Club there is a change in the way I perceive science and my children receive science. From the very onset I sensed this "get-together" was different. The members and leaders were a very "mixed-bag". Some had very strong science backgrounds and loved teaching science; some like me were not too sure of

themselves, and others felt somewhere in between. Right away the former group was good not to frighten the rest off with expressions such as "obviously". Very little in science was obvious to me. This atmosphere was very much fostered by the group leaders– who didn't seem like leaders but rather facilitators.

I very much enjoyed the group sharing that went on albeit a little hesitantly at first. It was very informal and at no time was anyone made to feel they had to share or made to feel guilty if they hadn't gone back to school and tried last month's units or experiments. Comfort level was key here. Everything was kept very practical and the pros and cons or pitfalls to topics or centres were discussed. Members quickly became comfortable with one another and I would feel at ease asking almost any member for advice, materials, information– we even share resource books.

I can admit to myself and my students that I don't have all the answers but I will help them find out or guess what is happening and why. My children are fond of science– experimenting with things at a centre, predicting, hypothesizing. They often choose books from the resource centre to accompany our present unit. We have found lots of ways to record findings and my observations of the children at work and play represent a larger proportion of the evaluation. People at school think I have a science background now, and ask me about science materials and units. I'm part of our schools' science planning team (as is a fellow member of the club). Science is no longer a scary subject– but one of fun centres, playing, getting right into things with the children, and discovering with them.

I would like to see the club continue as it is. We could include another member from schools where our present membership comes from. This helps the school as well as cutting down on planning and collecting materials, and provides a support group in each school.

Signed 'Jean'

P.S. Today when I asked the children to help me brainstorm for a memories page for our yearbook, I was expecting them to say trips to the Grand Theatre, skating, visits to the public library, but it was very interesting and rewarding to hear them mention frequently science-related topics like making all kinds of flight vehicles, observing insects...

IV. CONCLUSIONS

As the Science Club Project moves into its third year, its worth looking back over the first two years to consider some of the main things we have learned from the experience. In the vignettes from the teacher interviews of 1988 and in the teachers' writing done in the Spring of 1989, the teachers who participated in this program have expressed their views about the project and what it has meant to them clearly and often quite eloquently. Hence, rather than attempting to summarize the things they have said much better than I– as the participant observer– could, I will conclude this report by drawing attention to some of the central things I have learned through my participation in the project. These comments, observations and questions are based on my involvement for the past two years in the project as a participant observer during which time I have attended, observed and kept a diary on all but one of the Science Club meetings, participated in the presentations and hands-on activities presented to the teachers, talked to the teachers about the project and their lives in schools, spoken regularly with the instructors as they assessed one sessions' work and planned for the next, and interviewed the teachers and the instructors. I will concentrate on the Science Club as a vehicle for in-service education.

One of the most striking features of the project was the instructors' commitment to *educating* the participating teachers in science and the teaching of science. They were not at all interested in *training* them to carryout certain routines in the classroom– without providing them with a good deal of experience in, and firm grasp of the underlying rationale for, what was learned. Nor were they concerned to provide some form of *therapy* with a view to remedying some presumed deficit or defect in teachers' scientific repertoire. From the outset the aim was to help teachers to understand and appreciate what is involved in coming to see the world from a scientific point of view and to gain genuine enjoyment from engaging in inquiry. The challenge they faced, and continue to face, is a deep and widely shared conviction that science is something to be feared because it is beyond the grasp of ordinary people, especially elementary teachers. Allowing for the fact that the teachers who elected to participate are those one would normally expect to be less apprehensive, it was nevertheless clear that even they were fearful and lacking of self-confidence when it came to science and the teaching of science. In some cases the fear centered around an aspect of the larger enterprise, such as the physical sciences, while in others it was more generalized.

Against the background of this crisis in confidence and the widely promulgated view that elementary teachers are very poorly 'equipped' in science, it was remarkable to see these teachers gradually begin to gain confidence and slowly come to enjoy the opportunity to engage in inquiry using various types of hands-on activity. It quickly became apparent that one of the major obstacles they had to overcome was the notion that many of the activities people seem to spontaneously enjoy, such as blowing soap bubbles or carrying out various explorations with colour, have important scientific dimensions associated with them. As the teachers discovered, play or "messing about", especially under the supervision of experienced and insightful instructors can be a source of very rich and rewarding educational experiences. Of course, not everyone experienced a sudden surge in their confidence with science. Indeed, there were a variety of reactions. Some were hesitant to plunge into the middle of an activity. Instead they would take up a convenient 'post' somewhere near the action and make notes about the activities and the materials they observed, while others would move in cautiously and copy down the contents of the work cards that had been prepared for some of these investigations, and still others would travel from centre to centre observing their colleagues. Yet, as time went on there were fewer and fewer spectators.

Returning to the opening theme: What lay behind, and gave a distinctive direction to, the activities of the Science Club, were a number assumptions regarding the broader task of teacher education, the way teachers and children learn, and the kind of support systems required to sustain efforts to enhance the quality of teachers' professional activities. To begin with, although the project's aim was to enhance the quality of science education made available to youngsters in the elementary school and to do so by working with their teachers, the task was never conceived as a process of curriculum implementation or curriculum reform. It is, by contrast, viewed as an educational process: in particular, as a process of initiating teachers into some of the basic concepts and forms of inquiry characteristic of the sciences. In addition to helping teachers to gain a better understanding of science, it has a second and equally important purpose of assisting them to explore and develop ways of making certain aspects of science both intelligible and enjoyable to children. The first of these purposes was pursued by encouraging teachers to explore various activities involving hands-on materials and inviting them to ask questions, design and carryout experiments, to test hypotheses, and to seek explanations for the phenomena they encountered. Efforts to realize the second of these goals were supported by: small group discussions that took place spontaneously (and which were 'salted' from time-

to-time by the instructors raising of a provocative question or the setting out of a new challenge), large group discussions (referred to as "sharing time") chaired by the instructors, teachers' attempts to adapt and try out some of these activities in their own classrooms, and, in the latter part of the second year, videotapes of some of these attempts which were discussed during sharing time. In both of these areas the principle of choice played a fundamental role. Teachers were given the freedom to choose the hands-on activities in which they became involved and to decide whether, where and under what circumstances they would try them out in their own classrooms. An appreciation of this fact is clearly reflected in the interview vignettes and in the teachers' writings.

A second important assumption that shapes the direction of the Club's activities has to do with learning in general and with teachers' professional learning in particular. It is the idea that children's learning and teachers' professional learning are similar in a number of important, but often ignored, respects. All too often teacher educators, myself included, have attempted to persuade either pre-service or in-service teachers of the virtues of hands-on activities, or some other approach to teaching, by telling them about it. In doing so, we systematically ignore what we know to be its' principal merit; namely, the kind of proficiency or understanding that develops only through active engagement in the practice. No one becomes competent in hands-on science activities by being told about them, anymore than we become proficient in playing a musical instrument by listening to records or by attending lectures in music appreciation. And, yet, these teachers told us over and over again that the approach to in-service education, as well as to curriculum implementation, with which they were most familiar was 'chalk and talk'. For teachers who lack confidence or proficiency in using certain hands-on activities (or in other approaches to teaching), there is only one solution– practice, practice, practice, accompanied, of course, by the opportunity to reflect on and discuss their efforts with others having similar concerns! So the critical process for the teacher who decides to do something differently in their classrooms is *learning*, i.e., *learning how to do it*. Of course this is precisely what we seek for youngsters, when we encourage their teachers to make provision for them to engage in hands-on activities.

Once we begin to appreciate the significance of the point that programs of in-service education such as this one are centrally concerned with helping teachers learn how to do things, we must be prepared to allow for the fact that *learning of this complexity takes time*. Learning of this sort is complex in at least three ways that are particularly relevant to the present discussion. First, there is the intrinsic complexity

of science itself, of the scientific concepts and processes of inquiry into which pupils are being initiated. It is difficult to imagine a more richly elaborated and highly articulated form of understanding than modern science. The second source of complexity is found in the life of the teacher in the contemporary classroom. The decision to initiate one new activity, even within a given lesson, has consequences for the teachers' planning, for the way they organize the classroom, for their relationships with children, for their attempts to evaluate etc., that reach far beyond the particular change in question. Accordingly, the teacher who decides to do a unit on heat or light with a primary focus on hands-on investigations has embarked on a course strewn with many, often unforeseen, complexities In both instances significant accommodations must be made if the teacher is to persist and succeed in this new undertaking. The third source of complexity derives from the fact that teachers live and work in an environment in which the recent attempt to improve the elementary science curriculum is but one of a host of undertakings designed to alter the circumstances under which they practice. There are attempts to refurbish other fields of the curriculum and to introduce new ones, and to change policies governing such matters as pupil-teacher relationships, students with special needs, testing, marking and reporting. All of these place enormous demands on the time and energy of todays' teachers. In short, when we set out to enrich teachers' present understanding and to extend the range of their current practices in a certain area, we must *take the time* to do it. The history of the failed attempts at curricular reform, in science and elsewhere, during the 1960's and 70's warns us than there is more to curriculum renewal than merely changing the documentation.

It takes a special kind of *courage* for teachers to try something new. This is especially true given the complexities of their lives in schools and the fact that their present modus operandi may well be seen to be successful by most currently accepted standards. And, yet as we found with the majority of these teachers, they desire something more worthwhile both for themselves and the children whom they teach. At the same time, however, they also realize that any attempt to pursue even small scale changes will inevitably bring with it a certain amount of disorder and uncertainty and will surely lead to new kinds of problems and challenges. They must acquire the courage to take these risks. This points seems to have been implicit in the Ministry's *Statement of Direction* when it suggests the primary goal of innovative programs of in-service education should be that of *raising the comfort level of teachers*.

What can teacher educators do to help teachers develop the courage required to undertake something new? Perhaps the most important thing we have learned from the project to date is that the kind of support required can be provided by a diverse group of persons having a common interest who in time and through working together gradually come to see themselves as a community. The more people began to grasp the full significance of David Hawkins' remark that 'we are all in it together', the greater became the willingness to admit confusion and ignorance, to try things out (or to say that in their circumstances they were not yet in a position to seriously pursue new initiatives), and to share successes and failures. At the same time, as members of the Club came to trust one another and to realize that many of the things they were now doing or had thought about doing in their classes, were precisely the kinds of activities the Club was seeking to promote, the responsibility for planning the monthly sessions and bringing in activities for other members to try out began to be shared more widely among the group.

It has been remarkable to witness the personal transformation that some of these teachers have undergone. Several of the female teachers who at the beginning of the project made no secret of the fact that they had very little confidence in their ability to learn science, and even less in their ability to promote hand-on investigations in their classrooms, are now saying such things as:

> People at school think I have a science background now, and ask me about science materials and units. I'm part of our schools' science planning team (as is a fellow member of the club). Science is no longer a scary subject– but one of fun centres, playing, getting right into things with the children, and discovering with them. (Excerpt form Jean's letter, p. 66, above)

Can testimonials of this sort be taken to mean that the Science Club has been successful? This is not a simple question to answer. Given that the primary aim was to raise the comfort level of participating teachers, and that the notion of comfort level is a very complex and illusive one, this apparently straightforward query poses a number of questions. If it is taken as inquiring whether more teachers are now willing to become actively involved in hands-on investigations than there were at the start of the project, the answer must be, 'Yes'. If it is understood as seeking to determine whether teachers have come to see the potential scientific import of these investigations, the answer must, once again, be 'Yes'. If it is interpreted as the question of whether teachers are now doing more hands-on activities in their classrooms and doing them successfully the answer has to be, "In some cases, yes".

In other cases the answer is, "No"– although the number of these is decreasing month by month. And in still other instances, the proper reply, given the evidence available, is that "We don't know". We do know that at the end of the first year one of the members of the Club 'cancelled his membership', as it were, saying that, "He could see no way of integrating hands-on activities into his present classroom routines". And, finally, if the question of success is understood as raising the matter of whether the teachers have begun to develop a better understanding of scientific principles and processes of inquiry as they relate to the hands-on investigations in which they have engaged, the answer is that, "This is what the Club sees as one of its' principle, ongoing tasks". Some teachers have made these connections, others have just begun to do so, and still others are at the preliminary stages beginning to see possible "extensions", as they are referred to in the group.

If one were to attempt to judge the success of the Science Club by comparing it with other programmes of in-service education with a similar mandate, then, although the information we have on such endeavours is limited to what little is available in the current research literature and what we have learned from other in-service educators at a number recent national and international conferences, the verdict is that the Science Club is unique not only in its' approach to working with teachers but also in the length of time it has set as aside to pursue its goals and in the strong positive responses teachers are showing to the program– as evidenced in the vignettes and the teachers' writing. Teachers from other provinces and, indeed, from other nations have frequently remarked, when papers based on this work have been presented at conferences, that ,"I wish someone would take the time to do something like that with us!" A high school biology teacher from the state of Colorado, on hearing one of the instructors present this work, said to me, "I wish I'd had him as a high school science teacher". A final point on the topic of the projects' success comes from conversations with David Hawkins a co-founder and Director of the Elementary Science Study (ESS) in the United States. Hawkins and his colleagues were responsible for developing a rich array of high quality science curriculum materials and activities for use by elementary teachers. In speaking to the instructors he observed that, "The things you are doing with teachers are the things we should have done. At the time, we didn't realize the amount of time it would take for the teachers to become comfortable with activities of this kind." (David Hawkins, personal communication, 26 June 1989).

Prior to concluding this report, three additional comments must be made. The first is that the formula (Paul, one of the writers in year two, refers to it as 'magic') for

what success the Science Club has had, and in my judgement it has been considerable, is not readily transportable. In the last analysis, it is based on the enthusiasm and commitment of two extraordinarily talented instructors who understand teachers, the schools, children and their learning, and who, through their lengthy experiences both as classroom teachers, and as consultants, have gained access to an extensive array of both human and material resources relevant not only to science but also to other subjects on the elementary school curriculum. It was a humbling experience for myself, as a university professor strongly committed to many of the same educational ideals and practices, to witness the versatility of the two instructors as they not only did what I had long talked about doing but also adapted resources and activities to meet the diverse needs of the teachers involved in the project. In my judgement the atmosphere that grew out of their belief that these teachers did not need "fixing", their caring attitude, and the enormous amount of time they took, over and above that spent in monthly meetings, in talking and thinking about the members of the club will be difficult to duplicate.

Without question the commitment, capabilities and demeanours of the two instructors were crucial ingredients in raising teachers' comfort level. A careful reading of the vignettes and writing above will also show that the Clubs' activities have been instrumental in advancing the Ministry of Educations' other priorities in elementary science; namely, in providing leadership opportunities for teachers involved in the project, helping girls to develop and maintain an interest in science, and enabling youngsters to see that science can grow, albeit indirectly, out of the world of their everyday experiences. There was no direct opportunity for the Club to adapt its activities to the needs of teachers in French speaking schools since no teachers from such schools have as yet become involved in the program.

The third comment has to do with the advantages associated with the collaboration between the two local school boards and the university. Although, at times things were difficult to arrange on the administrative side– and only then because of a lack of any developed procedures or pathways for doing them, but certainly not from a lack of good will, the benefits of this collaboration have been far reaching and profound. We have come to understand much better than before one anothers' professional responsibilities. We have come to a much fuller appreciation of the complexities of the relationships between 'practice' and 'theory', of the fundamental and, often suppressed, role of moral issues in the educational enterprise, and to a better understanding of the strengths and weakness of contemporary educational scholarship and research in illuminating the problems of

professional practice. We also realize that much remains to be done. Speaking personally, the opportunity I have been given to become involved in the Science Club was, and continue to be one of the most worthwhile experiences of my professional career.

FOOTNOTES

1 David Hawkins was the director of the Elementary Science Study (E.S.S.) and is co-founder of the Mountain View Centre for Environmental Education in Boulder Colorado. Frances Hawkins is co-founder of the Mountain View Centre and author of *The logic of action*. Maya Apelman was on the staff of the Mountain View Centre. She presently does free-lance consulting for schools.

2 A lucid and detailed description of the role of the teacher under these sorts of circumstances is offered by David Hawkins in 'What it means to teach'.

> Let the learner be a young child not much given to long discourses, but present and operative in a material environment which the school and the teacher have provided, and let the child be singled out for attention because of any one of a variety of circumstances– manner of association with others in a specific activity, manner of involvement or non-involvement with materials, content and style of communication, etc., etc. The teacher begins to assemble such information over a variety of children, although for thirty the task is enormous, and even the best teachers will confess many omissions. Then there is a trial-and-error of communication, further observation, a gradual and still tentative portraiture involving the child's style– strengths, weaknesses, skills, fears and the like. I single out one aspect of this complex, the way a child comes to grips with some subject matter' matter originally provided because it matches the general level of interest and ability of a still individually unknown group– building blocks, clay, paint, batteries and bulbs. If this subject matter represents something which the teacher has valued and learned from, and seen others learn from, then the teacher has a background for reading the behavior of that child. In a film from Cornell University, a series of kindergartners come spontaneously to a table to play with an equal-arm balance and a large number of washers and other weights. In watching the film, the observer begins to recognize in himself– if he is personally familiar with the large variety of balance situations which are possible here, and with some of the underlying ideas– the ability to read the levels and the specializations of interest represented in these children, no two alike. What he finds himself doing (but only if he is acquainted with kind of balance phenomenon and others related to it) is beginning to build what I would call a map of each child's mind and the trajectory of his life. It is fragmentary, fallible, but it is subject always to correction. And next the observer thinks to himself, what could I do to steady, extend, deepen this engagement I have glimpsed?
>
> The important thing is that, as in all self-instruction, the participant does something. The diagnostic hunch leads to some special provision for this child or that twosome, some intervention, some special protection for a delicate and perhaps fearful beginning, some withdrawal of old materials and insertion of new ones. With large groups the teacher must be a manager of great skill evolving a context in which most are involved and self-directing most of the time, so he can really focus for a period on one or a few– discussing, joining, enjoying, directing of deferring to a child's directions.

In every case, the aim is to repeat this cycle of diagnosing, designing, responding, and then rediagnosing from failure or from a child's confirmation of success. That's the cycle, and with variations it recurs over and over again, never twice the same in detail but with an assurance that will grow by what it feeds on– the finding of a match and mismatch between children's as their teacher reads them and those kinds of order and organization this reading has helped them to extract from their world. I think that is the way it is, every day. (pp. 13-14)

REFERENCES

AAAS. (1989). *Science for all Americans: A project 2061 report on literacy goals in science, mathematics and technology*. American Association for the Advancement of Science: Washington, D.C.

Apelman, M. (1984). Critical barriers: Learning about light and colour, *Outlook*, (53), 3-38.

Ausubel, D. (1968). *Educational psychology: a cognitive viewpoint*. New York: Holt Rinehart & Winston.

Dearden, R. F. (1968). *The philosophy of primary education*. London: Routledge and Kegan Paul.

Dearden, R. F. (1976). *Problems in primary education*. London: Routledge and Kegan Paul.

Dewey, J. (1938). *Art as Experience*. New York: Minton & Balch.

Donaldson, M. (1978). *Children's minds*. London: Fontana.

Farquhar, D. & McAndrews, B. (1987). *Science in primary and junior education:* Proposal Submitted to the Innovative In-service Incentive Fund of the Ontario Ministry of Education. Mimeo.

Hawkins, D. (1965). Messing about in science. *Science and children*, 2(5), 5-9.

Hawkins, D. (1973). What it means to teach. *Teachers College Record*, 75(1), 7-16.

Hawkins, D. (1974). I, thou and it. In D. Hawkins, *The informed vision: Essays on learning and human nature* (pp.48-62). New York: Agathon Press.

Hawkins, D. (1978). Critical barriers to science learning. *Outlook*, Autumn (29), 3-23.

Hawkins, D., Apelman, M., Colton, R., & Flexer, A. (1982). *A report of research on critical barriers to the learning and understanding of elementary science*. (Contract No. SED 80-08581). Washington, D.C.: National Science Foundation.

Hills, G. (1989). Student's "untutored" beliefs about natural phenomena: Primitive science or commonsense? *Science Education* , 73(2), 155-186.

Hills, G., McAndrews, B. & Farquhar, D. (1988). *Raising the comfort level of elementary teachers with teaching of science: a collaborative project*. A paper presented at the SSHRC Invitational Conference on School-Based Research and Constructivist Science Teaching, Vancouver, B. C.

Miller, J.D. (1983). Scientific literacy: A conceptual and empirical review. *Dædalus*, 112(2), 29-49.

Ontario Ministry of Education (1986). *Science in primary and junior education: a statement of direction*. Toronto: Ministry of Education.

National Science Teachers Association Working Paper. (1982). *Science education: accomplishments and needs*. Columbus, Ohio: ERIC/SMEAC.

Novak, J. (1977). *A theory of education*. Ithaca, N. Y.: Cornell University Press.

Petrie, H. G. (1981). *The dilemma of enquiry and learning*. Chicago: University of Chicago Press.

Piaget, J. (1962). *Comments on Vygotsky*. Cambridge, Mass.: M.I.T.

Posner, G. J., Strike, K. A., Hewson, P. W. & Gertzog, W. A. (1982). Accommodation of a scientific conception: toward a theory of conceptual change. *Science Education*, 66(2), 211-227.

Rowland, S. (1987). Child in control: towards and interpretive model of teaching and learning. In A. Pollard (Ed.), *Children and their primary schools*. (pp. 121-132) Philadelphia: Falmer Press.

Science Council of Canada. (1984). *Science for every student: Educating Canadians for tomorrow's world*. (Science Council Publishing No. 55 -1984/36E). Hull, Quebec: Canadian Government Publishing Centre, Supply and Services Canada.

Smith, D. C. (1987). Primary teachers' misconceptions about light and shadows. In J. Novak (Ed.), *The second international seminar: misconceptions and educational strategies. Volume 2* Cornell University, Ithaca, NY. (pp. 460-477) Cornell University, Ithaca, NY.

Snow, C. P. (1959). *The two cultures of the scientific revolution*. Cambridge: Cambridge University Press.

Stake, R. & Easley, J. (1978). *Case studies in Science education*. Urbana, Ill.: Center for Instructional Research and Curriculum Evaluation, University of Illinois.

Strike, K. A. & Posner, G. J. (1985). A conceptual change view of learning and understanding. In L. West and A. L. Pines (Eds.) *Cognitive structure and conceptual change*. (pp. 211-231). New York: Academic Press.

Yager, R. (1984). Toward a new meaning for school science. *Educational Leadership*, 42(4), 12-18.

Yankwich, P.E., Eberhardt, W.H. Lavallee, D.K. & Schwartz, A.T. (1984). Recommendations of the American Chemical Society Education Task Force. *Journal of Chemical Education*, 61(10), 845-847.

APPENDICES

Appendix A

Assessment Spring 1988

- Letter of Explanation to Teachers
- List of Questions From Which Interview Topics Were Drawn

To:

Queen's University Memorandum

From: Skip Hills

Date: 18 May 1988

Subject: Meetings to talk over the Innovative In-Service Program in Elementary Science

This note is to remind you that Primary and Junior teachers involved in the Innovative In-service Project in Elementary Science will be getting together to talk over their experiences in the project on the following dates:

PRIMARY TEACHERS — Thursday May 26th from 1:00-3:00 pm. at the F.J. Fowler Teacher Center.

JUNIOR TEACHERS — Friday May 27th from 1:00-3:00 pm. at the F.J. Fowler Teacher Center.

The primary purpose of these discussions will be to provide me with information that I can use in my report to the Boards and the Ministry. My hope is that this report will accurately reflect your ideas concerning what you found helpful and worthwhile about the project and what you think could be improved–if it were to be done again. This information will also help Doug and Brian to plan the second year of the In-service.

In order to help focus the discussion, I have included a lengthy list of questions. Please don't be overwhelmed by them. There purpose is only to help me focus my thinking, and to give you some indication of the main areas I'm interested in covering so that you might begin to think about them before you come. Since it's likely that I have underemphasized or overlooked parts of the project you regard as important, I have left space on the final page for you to jot down points you want to bring up.

Please remember to contact your Board in order to arrange for a supply teacher on the day you will be coming. Both Boards have been notified about these meetings and will be expecting your call.

If you have any questions or concerns about these sessions you would like to raise with me before these meetings, please don't hesitate to give me a call. My office number is 545-6260. And I can be reached at home, after 6:00 p.m., at 384-3547.

Joint Project sponsored by
The Ontario Ministry of Education
together with
The Frontenac County Board of Education
and
The Frontenac, Lennox & Addington R.C.S.S.B
Kingston, Ontario

Innovative In-Service in Elementary Science

Questions for Teachers

I. BACKGROUND:

A. Reasons for Becoming Involved in the Project

1. How did you first learn of the project?

2. Why did you decide to participate in it?

B. Hopes and Expectations for the Project

1. What sorts of things did you expect to get out of the experience, personally and professionally?

2. What other expectations (or doubts or reservations) did you have on coming into the project?

II. THE PROJECT ITSELF: WHAT WAS DONE (CONTENT, FORMAT AND GOALS OF THE PROJECT).

1. What did you like most about the project? Why?

2. What did you like least about the project? Why?

3. Of the various activities the coordinators (Doug and Brian) organized for you, which did you find the most beneficial? What was it about these activities that made them helpful?

4. Which of these activities did you find these least helpful? Why do you think they were not as beneficial to you as the others?

5. Have you tried out any of the activities that were presented in the workshops by the coordinators? How about some of the activities presented by guest presenters (e.g., Barb Lawson or Al Hurd), or those discussed during the year in 'Sharing Time'? Have you had a chance to try some of the things described in *Science Is*, or in the final 'Make and Take' Session?

6 If you tried them, how did the students react to them? How did it compare to their response to other kinds of things you normally do with them in science? How do you feel about their response? Were there any surprises?

7. Are there any special advantages to using activities of this kind with your classes. What are they? And why do you think them advantageous?

8. What are the main disadvantages of using these sorts of activities with your classes? And why do you think them as disadvantageous?

9. Did any of the sources mentioned in # 5 above give you ideas about new ways of approaching topics other than those that were actually discussed or demonstrated?

10. How do you feel about the idea of visiting the class of another teacher involved in the project in order to help them try out some new science activity?

11. What are the advantages and disadvantages of having someone visit your class to help you try out a new activity?

12. On a number of occasions during the year, the coordinators suggested that it might be useful to videotape people's attempts to try out new activities. Each time some people in the group seemed to react as if they were uncomfortable with the suggestion. Do you know why they might have felt this way? Please explain.

13. Why do you think the coordinators were interested in having videotapes made of what use would they be in this project?

14. How would you feel about having your efforts to try out a new activity videotaped by one of the other teachers in our group, or by one of the coordinators? What would be the main advantages and disadvantages of this on your view? Would you be willing to share the tape with a colleague in our group? With the group as a whole?

15. Would you feel differently about videotaping if the focus was on the childrens' responses to the new activities you were trying out with them? Would you be willing to share this tape with a colleague? With the group as a whole?

16. What did you think of the workshop conducted by Frances and David Hawkins, and Maya Apelman? What about their approach and materials did you find to be the most interesting and helpful? And what about their approach and materials did you regard as least interesting and helpful?

17. How would you describe the approach and materials presented in the Hawkins-Apelman workshop? How is it similar to, and how does it differ from, other elementary science workshops you have been involved in?

18. How would you compare the approaches used by the coordinators (Doug and Brian) with the approaches used by the people in other (elementary science) workshops you have attended?

19. As you reflect on what took place during the past seven months, what would you say were the coordinators major goals and objectives for this in-service programme? What were the main things they were trying to help you accomplish with science?

20. At which of these things were they the most successful? Why?

21. And, at which of these were they least successful? Why?

22. When the Ministry of Education invited local school boards to try out some innovative approaches to providing in-service education in elementary science, they placed particular emphasis on five main areas. They indicated that special consideration would be given to projects which:

    – "support an integrated, child-centered and balanced program in science;

    – address the special need of girls in relation to kindling and maintaining interest in science;

    – provide, where applicable, for in-service activities for teachers in both French and English schools;

    – provide leadership opportunities for women;

    – address the issue of the application of science in the real world of the child."

    How would you rank these concerns in order of the priority they have for the situation in which you teach? In other words, which of these do you consider the most, and which the least, important? Why?

23. To what extent has the program of activities in which you have just participated been successful in meeting these goals? Which of the goals have been most successfully met? Why?

24. Which of these priorities did the project address least successfully, on your view? Why? What steps might be taken in future projects of this kind in order to achieve these goals?

III. THE IMPACT OF THE PROJECT: WHAT YOU LEARNED

A. Personal and Professional Relationships

1. What have you learned about your colleagues over the course of these seven months?

2. How do you see yourself in relation to the other elementary teachers involved in this project?

3. Has this changed at all since this project began in the Fall? In what ways?

4. How, if at all, has it affected your personal or professional relationship with them?

5. What effect has your involvement in the project had on your relationships with other people in your school, especially with your principal and other teachers?

B. Approaches to Teaching

1. Has your participation in this project made any difference to how you feel about teaching science in your classes?

2. Has it had any affect on the approach you use in teaching science?

3. Has it made any difference to the way you teach other subjects?

4. As a result of the project, have you noticed any changes in your relationships with your pupils (or their parents)?

5. What have you learned about yourself as a learner as a result of your involvement in the project?

6. Have any of the activities in the project given you any new insights into the way children think or learn, or into what they enjoy doing? Please explain.

7. How would you compare your experiences in this project with your experiences in other types of in-service, such as workshops and Ministry courses, especially with reference to what you do in your classroom and what you think about your teaching. What, if anything, did you find unique or different about this program of in-service?

8 Has it had any effect on your ideas about what doing science involves, or on confidence in doing science with your class(es)?

Appendix B

Assessment Spring 1989

- Science Club Writing Activity Outlined

THE SCIENCE CLUB

Writing Activity

27th & 28th April 1989

In planning for next years activities, we would like to get a better picture of the strengths and weaknesses of what we have done in the Science Club so far, and of how this might be improved for next year. We are interested learning more about your views concerning what it has been like to be involved in the activities of the Club, the primary goal of which has been to, "to raise the comfort level of elementary teachers with science and the teaching of science". It would help us to know whether the activities of the Science Club actually are actually helping to raise your comfort level and if so in what ways. Accordingly, we would appreciate it if you would share with us some of your ideas concerning the ways in which the activities of the Club have affected your teaching, especially in the area of science.

Below are some questions that may help to spark your reflections on your experiences in the Science Club. They are to be treated *only as suggestions*. If you would prefer to write about something else that has nothing to with these questions, please ignore them. In addition to these questions, we have attached some samples of work done by high school science teachers in Great Britain to give you a clearer idea of what this writing *might* look like.

- **As you look back over your experiences in teaching since you have been a member of the Science Club, what do you most enjoy about teaching itself?**
- **What do you enjoy least?**
- **What were the most significant day-to-day concerns you are no facing in teaching science?**

- What was the most rewarding or satisfying experience you had in science during the past year? Why did you find it rewarding?

- What was the least satisfying experience in science? Why did you find it unsatisfying?

- What aspect of teaching do you find is the greatest source of dissatisfaction or worry?

- What were the main problems you were grappling with in your teaching?

- What things is your working environment would have to change in order for you to become more satisfied with your teaching? Why? Could the Science Club help in this and if so how?

- And if you could change certain things about yourself through learning so as to become a more satisfied with your teaching, what would you change? Why? Could the Science Club help in this and if so how?

- What are some things the Club might do next year that it hasn't done so far?

These questions are meant to be taken as invitations to you to reflect on and write about some part of your experience since you have been involved in the Science Club. Because the primary purpose of this activity is to encourage you to focus on something that interests you, to write about it, and to share your reflections with other members of the club, we would ask you to write in a way that you find best communicates the way you think about these things. ***Please do not aim for a highly polished , final draft product.*** You might begin by making some preliminary notes in response to one of the questions above or one of your own questions. Use point form or any other format that you find most suitable- anecdotes or stories are appropriate. Write as if this were to be put in your own diary or to be shared with a trusted colleague or friend.

We will set aside time during May meeting for you to share these reflections with other members of the Science Club. Please bring your writing to the May meeting of the Science Club.